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THE UNIVERSITIES AND INDUSTRIAL MANAGEMENT

THE Productivity Team of the Anglo-American Council on Productivity which, under Col. L. F. Urwick's leadership, recently visited the United States, was deeply impressed by the steps taken by American business to educate, train and develop its future business leaders, and is convinced that the results of these efforts have had, and will continue to have, a vital bearing upon American productivity. More than two million students are receiving higher education at university level, and in 1950, besides the degree courses in business and commerce offered in 617 institutions, many technological courses included administrative studies. The 'graduate' business schools, among which the Harvard Graduate School of Business Administration is outstanding, are winning increasing support. They usually require two years of full-time study in addition to the four years for a first degree, and the Massachusetts Institute of Technology is seeking to develop a school of social science with a status equal to that of its great technological departments. The report of the Committee on Educational Survey of the Institute, issued a short time ago, showed the importance attached to helping prospective scientific men and engineers to understand the forces moulding contemporary society, and the Institute has recently accepted a large endowment for the development of a School of Industrial Management.

The Carnegie Institute of Technology, Pittsburgh, is also heavily endowed for teaching and research in the social sciences and has established a School of Industrial Administration. Much of the instruction organized in Britain by professional bodies is, in fact, undertaken in the United States by university institutions, and the staff engaged in teaching administrative studies is of high quality. The Productivity Team, moreover, found no evidence of a wide difference between American and British ideals of education: the former is not excessively vocational, although the American system probably pays more attention to the vocational interests and ambitions of students than is usual in Britain. The mere fact that a subject is vocational constitutes no bar to its inclusion in university curricula; but in the universities, as in business itself, there is a dominant emphasis on the importance of human relations and the techniques of communication.

The objectives of the schools of business administration are summarized in this report as fourfold: first, to provide the student with the requisite knowledge of the tools necessary for the profession of business management, and of the functions and principles of management; next, to train in the ability to work effectively with people and to give some knowledge of the problems of human relationships at all levels; third, to give an understanding of the social purpose of industry, of the relationship between industry and other groups within the community, and of its relationship to the Government and the general public; and lastly, to develop certain abilities and qualities of character necessary

for the practice of business administration, such as a capacity for exact analysis and the ability to make effective decisions under pressure of time. Within this broad framework there are substantial variations both in emphasis and method; but such a programme in Great Britain would go far to remedy the failure of British industry to make the fullest use even of the scientific man-power already at its disposal. On this, as well as on the need for using scientific men and technologists on a much greater scale, Mr. N. G. McCulloch, the chairman of the Shirley Institute, Didsbury, as well as Mr. Allendale Sanderson in the *Twentieth Century*, have commented strongly since the Productivity Team on the relations between universities and industry in the United States reported in the same sense. The need for action is urgent; but there is nothing in either of these Productivity Team reports (see *Nature*, January 5, p. 1) to justify rash copying of American practice. On the contrary, they are a challenge, not to imitation, but to the evolution of means appropriate to the conditions and genius of Britain.

This report on education and management gives no clear answer to the questions whether there is such a thing as scientific management and, if so, whether it can be reduced to a university discipline meeting such criteria as Prof. G. B. Jeffrey set forth in his Eddington Memorial Lecture. It seems probable that the universities can best help in this matter at the graduate level, and the report makes a good case for a British equivalent to the Harvard Graduate School for Business Administration for graduates who wish to make business their career, and for men from industry who have gained enough practical experience to profit from a short course. Experience might well show that such an institution could also provide something on the lines of a staff college for younger men than those who at present go to the Administrative Staff College. Such developments, moreover, by feeding industry with more men, and especially technologists by training rather than lawyers or accountants, competent to handle problems of administration scientifically and imaginatively and with full regard to the social implications and the problems in human relations which arise out of their work, could go far to meet the need to which Lord Hankey directed attention in his recent lecture on higher technical and scientific man-power. It might, indeed, prove unnecessary to establish a separate college for science and technology; expansion of the Administrative Staff College could perhaps cover sufficiently the study of the science and art of higher scientific and technological administration, with the advantage of the wider contacts which would follow in such a community with a varied range of interests.

The Administrative Staff College is already attempting to bring together those who have carried comparable responsibilities but who have different types of training and experience. By encouraging them to increase their capacity to work together and to interact effectively upon each other, the Administrative Staff College is thus meeting one of the needs visualized by Lord Hankey and bringing together people with totally different experience in various branches of government and administration. Potentially it could do something to provide the men required for the higher direction of those groups of science or technology to which Lord Hankey referred, as in its own way it could make some contribution in supplying men who can bridge the gaps between different disciplines or branches of science and technology, including economics, on which Prof. R. S. Edwards has laid such stress.

This is an important advantage in developing or modifying existing institutions. No less important could be the economy in staffing. Even the American institutes with their large financial resources have difficulty, as Prof. Edwards recently reminded us, in finding social scientists of sufficient quality and experience who have directed their thinking and research to the problems of industry, its economics and administration. The difficulty is likely to be even more acute in Britain and should lead us to consider very carefully both the content of the curricula of courses in the expanded technological institutions or technological departments of the universities and of the management courses themselves. Apart from the staff question, the wider the range of studies that are associated in the community which constitutes either body, the more stimulating the contacts are likely to be and the greater the opportunity for students to come under the influence of leading minds from many different branches of technology and science and the humanities.

The Productivity Team on the Universities and Industry found that the teaching and standards of British university and technological education compared well with those of American institutions: even at the Massachusetts Institute of Technology, teaching at the undergraduate level compares poorly with that in Britain. The American advantage lies in the scale of the training of the middle levels, and the readiness with which those who obtain a first or second degree are absorbed in industry, whether on the technical or the administrative side. Comparison of the numbers of those receiving the degree of doctor of science or technology in the United States with those in Great Britain receiving the master's degree or doctorate, on a population basis, shows, indeed, an advantage to the United States in the production of scientific workers at the higher level, and an advantage to Britain in respect of engineers at the higher level.

Nevertheless, an expansion in the facilities for technological education in Britain at the highest level is required, and this should include, as the Percy Report suggested in 1945, adequate provision for management studies and research at that level. The major requirement, however, is the expansion of facilities for technological training for students of ordinary ability; and on the evidence of these reports it should not be a difficult task to meet the need by suitable expansion of technological departments at some universities, the upgrading to university status of a very small number of selected colleges of technology, with their own governing bodies, fully

independent of local authority or any other control, and possibly the establishment of a single new technological institution. The question of administrative staff college courses could well be left for consideration and integration with such developments, or with the existing Administrative Staff College.

The important things are that action is urgent, that dissipation of resources over institutions should be avoided, that decisions should be based on considerations of national interest and resources and not determined by sectional prejudices and jealousies, and that the fullest co-operation should be secured between industry and the universities and the technological institutions themselves. This is essential if the expansion is to be planned and executed in relation to the existing resources of man-power for staff: the staff required, it should be remembered, must be of that high quality which is already in demand by industry, and which the universities and colleges of technology as well as government departments already find it so hard to recruit. Co-operation between industry and the universities and technical colleges along American lines in the exchange or release of staff may help here, but it is no less important that the expansion should proceed with the full support and understanding of industry so as to ensure also the smooth absorption into productive purposes of the graduates coming from the new and expanded institutions.

Discussions on the arts graduate in industry at the British Institute of Management's Conference at Harrogate in November suggest some doubts on this point, and there must be some mutual understanding on both sides as to what to expect of the arts graduate and those trained in management, and what they should in turn expect to find in industry. However willing such graduates may be to start from the lowest grade without preferential treatment, there are clearly prejudices to be overcome; and apart from the waste of trained man-power which may arise if, in fact, there are not sufficient openings to ensure rapid promotion, the best men are not likely to be attracted unless the prospects and especially the status offered are good. That is one reason why the development and strengthening of close co-operation and relations between industry and science is an urgent need, demanding the utmost goodwill of leaders on both sides. That includes the trade union side also. Even in the United States, the three-fold link between universities, business and the unions has not fully developed, and the Management Team's report shows that the relation between the unions and management in this matter is less co-operative than in Britain. A recent study from the Acton Society Trust, however, pointed out how much trade unions in Britain need the leaders such courses could train, and a like point was made by Mr. S. G. Raybould in his recent book on adult education. More than this, if the problem is that of raising the level of training of those entering industry over a wide field, from the school level upwards, the understanding and active co-operation of the unions as well as of other professional bodies is essential. However successfully we bridge the gap at the highest level between the several specialist disciplines and technologies, the productivity-level in industry will not begin to rise to that of American industry without a new spirit and an adaptability that only the absorption in much greater numbers of men and women of much improved technical education can provide. That is a matter not simply of education but of co-operation in industry and between management and workers. There must be understanding on the part of the unions as well as management; and the fullest advantage must be taken of the better relations which exist in British industry as compared with the United States, if we are to use for higher productivity the advantages which an improvement in technical education, in technological education and indeed in training for administration, could bring us.

Greater awareness of the social issues on the part of management will not by itself suffice: the gap between worker and management must also be bridged. Sir Harold Hartley recently emphasized in this connexion the important contribution to further education which the Workers' Educational Association and the extra-mural departments of the universities are already making, and its bearing on such matters as joint consultation, productivity and the like. No expansion of facilities in training for management will suffice which does not take account of the needs of the trade union movement itself for men of administrative ability and of wide outlook. The expansion of technological education must be boldly conceived indeed, and have full regard to the native genius of Britain. It must avoid the danger of copying institutions elsewhere that themselves are changing. It must be dynamic, but it must also be balanced and broadly based on an educational system organized to supply the technicians and the workers in industry and business at all levels, whose understanding and co-operation are just as essential as that of the technologist himself.

It is possible that the development of *alumni* associations suggested by the Productivity Team on Universities and Industry might make an important contribution in promoting such co-operation and understanding. The Team was impressed with the extent of such associations in the United States, and with the value of their work in bringing the universities and industry and the community in general into close touch. An increase of such associations in Great Britain would possibly help the work of the University Appointment Boards and the placing of men in industry. It would widen and deepen the channels of communication between university and industry, and assist in the task of bringing the whole community to appreciate the urgency and the magnitude of the whole task of expanding the technological and technical education in the widest sense, and the dependence of our economic future upon its effective discharge.

It is necessary also to remember that this association of professional and technological studies with the universities, and of the universities themselves with industry and the surrounding community, which

is now so strikingly exemplified in the American educational system, was advocated by the late Prof. A. Smithells in Britain thirty years ago and by Lord Haldane ten years earlier. Example may perhaps rouse to emulation where precept, for all its perennial eloquence, has failed to move.

THE LIQUID STATE

An Advanced Treatise on Physical Chemistry

By Prof. J. R. Partington. Vol. 2: The Properties of Liquids. Pp. xliv+448. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1951.) 50*s*. net.

THIS book extends to liquids the general type of treatment given for gases in the first volume, the emphasis being again on the historical and experimental aspects of the subject. An adequate thermodynamic treatment is given for each property, but the molecular theory of liquids is disposed of in four pages. The author's attitude to recent developments in this field is best expressed in his own words (p. 4)—"The theory of liquids has been the subject of many recent papers [121 references 1923–49], but it is not ripe for summarising in a systematic treatise, as distinguished from a progress report". It is not only the modern mathematical theory of liquids which is thus dismissed, for the book contains no discussion of the distinction between associated and non-associated liquids, apart from an occasional mention that particular relations are obeyed less well by associated liquids. Some readers will welcome this attitude as sound conservatism; but others, probably more numerous, will regard it as a serious defect in a modern advanced treatise on the liquid state. We shall not attempt to argue the general point here, and in the remainder of this review the book will be considered within its own terms of reference.

If we accept the limitations which the author has himself imposed, there is no doubt that he has done his work extremely well. The descriptions of experimental work are clear, concise and well illustrated, and there is often an admirable critical comparison of different methods. Prof. Partington's wide and deep knowledge of experiment provides many small pieces of useful practical information; for example, on the spheroidal state, the prevention of 'bumping' in vacuum distillation, the unsuitability of chromic acid–sulphuric acid mixture for cleaning glass, and the accuracy attainable with the ordinary density bottle. Older experimental work receives more attention than is usual nowadays, and in the reviewer's opinion this is a valuable feature of the book. Quite apart from the historical interest of such work, there is much truth in the statement in the preface: "It is more than likely that the experimental material presented by Regnault, Stas, Lord Rayleigh, or T. W. Richards, to name a few of the old masters, is at least as good, other things being equal, as that given in recent papers by a post-graduate student". The properties dealt with include density, thermal expansion, compressibility, viscosity, thermal conductivity, surface tension, specific heat, vapour pressure, boiling point, latent heat of evaporation, and the critical state. Solutions have been deliberately omitted, but it is surprising that there is no section on the electrical properties of pure liquids, since the study of properties such as electrical conductivity, dielectric constant and dielectric loss has led to much information about the structure of liquids.

Like the preceding volume, this book is remarkably well documented, and contains 11,758 references to the literature, many of them to little-known publications. There are also many tables of numerical data, collected from the most diverse sources, which form a useful supplement to the standard works of reference. It is doubtful, on the other hand, whether much useful purpose is served by the long compilations of empirical expressions, for example, thirteen pages devoted to relations between viscosity and temperature. However, the major contribution of Prof. Partington's book is to render available a large amount of valuable experimental information which might otherwise escape notice. Physical chemists have cause to be grateful to him for the skill and labour which he has devoted to this task.

R. P. Bell

ENGINE LUBRICATION IN PRACTICE

Properties of Lubricating Oil and Engine Deposits

By C. A. Bouman. Pp. viii+170. (London: Macmillan and Co., Ltd., 1950.) 15*s*. net.

AN original method of treatment of this subject is adopted by Mr. C. A. Bouman, who is a member of the Royal Dutch/Shell Group's laboratory at Delft, which has for many years been a source of valuable information. The present work is in the authentic Delft tradition; it is based on the author's own tests rather than on other material available.

Mr. Bouman states in the preface that "the subject 'engine fouling' does not lend itself to an exact treatise. At best, some general rules can be set up, which can be illustrated by means of practical examples". Most knowledgeable workers in this field will agree with that statement. The many practical examples given add much to the value of the book. The author sets up some general rules, which will be useful to the student and engineer alike.

The early chapters re-state in simple form the generally accepted theories of friction, with particular reference to the lubrication requirements of engine bearings, pistons, and cylinders, interspersed with a rather scanty reference to the classification and manufacture of lubricating oils. A brief chapter then follows restating some laboratory tests for fresh lubricating oils. The chapter heading 'simple' may give a false impression of the strict requirements of such tests, particularly as reference is made to the use of these tests to identify oils. References are made to the Standard Methods of the Institute of Petroleum dated 1942 and 1944. These methods are reviewed yearly, and Mr. Bouman might better have referred his readers to the current editions, even though there have been only minor changes to date in the tests quoted.

A short but valuable chapter on the volatility of lubricating oils leads up to the main part of the work.

This main part covers many factors of engine component wear, lubricating oil consumption, contamination of both oil and engine by combustion products, and deterioration under various temperature conditions. The author quotes from both petrol and diesel engine tests, and is inclined to combine the

results from each, making it less easy for the reader to discern factors related to engine tests with widely different conditions of fuel, combustion, temperature, and pressure.

The later chapters, on carbon, lacquer and sludge deposits, piston ring sticking, and engine maintenance, are most interesting and of great value. They would have been even more valuable if the author had given a little more than a hint of the type of engine tested, and, in the case of diesel engines, the fuel used.

The last chapter is concerned with the practical testing of lubricating oils—a subject ample for a book on its own. The author treats it briefly, although with authority. The earlier text indicates that the author has conducted many hundreds of hours of research, and has considerable experience on the practical testing of lubricating oils. This experience would be worth setting out in print. The author rightly stresses the difficulty and importance of reproducibility in all engine tests of lubricating oils.

The work is commendably illustrated with many simple graphs, is practical, and fills a gap between the short published findings of various laboratories on engine deposits and the large number of books on advanced chemistry of lubricating oil.

The translator from the Dutch has served the author and reader well, but has stopped short at the text. Many English-speaking readers would have been grateful had the metric units been transposed into those with which they commonly work.

K. G. FIRTH

PETROLEUM GEOLOGY

Petroleum Geology

By Dr. E. N. Tiratsoo. Pp. xix+450+8 plates. (London: Methuen and Co., Ltd., 1951.) 42*s*. net.

Petroleum Geology

By Prof. Kenneth K. Landes. Pp. xi+660. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1951.) 80*s*. net.

THE geology of oilfields has become such an immense subject that it is impossible to cover the whole range adequately within the confines of a single volume. Both these books are worthy attempts to do so; but both may be criticized for attempting too wide a field. They are primarily books for students, but, even making allowance for this, their value would have been greater if the non-geological sections could have been shortened to allow of more adequate treatment of the important descriptions of the geology of the oilfields of the world. Dr. E. N. Tiratsoo, for example, uses up many pages on topographical survey technique, geophysical technique, correlation of wells and drilling muds, and Prof. K. K. Landes similarly occupies more than a hundred pages on his introduction and on the techniques of drilling and sampling wells.

In Prof. Landes's book the section on the accumulation of oil and the various types of traps is very good and well illustrated with maps and cross-sections of typical cases, and this leads on to individual descriptions of the oilfields of the United States and then of the rest of the world. There is an abundance of illustrative maps, perhaps unnecessarily many, as there is some repetition, and some of the maps might with advantage be replaced by cross-sections. Some countries receive rather summary treatment through lack of space—Germany, to take a case at random, is covered in two pages, including a small outline map. The final chapter discusses the proved reserves in the known oilfields of the world, giving the estimate in 1949 of 83,000 million barrels, of which 28,000 is in the United States and 32,000 in the Middle East. At the 1949 production-rate these reserves constitute only twenty-two years of assured supply, but no figure is suggested for the reserves resulting from discovery of new fields or from more efficient recovery from the old. In the United States the continental shelf, particularly in the Gulf of Mexico, is expected to contain a large reserve, and there is still large scope for discovery elsewhere, perhaps particularly along the Rocky Mountain front both in Canada and in the United States. Elsewhere in the world the immature stage of exploration in many South American countries, in Russia, Siberia, China and elsewhere is described, and undoubtedly there is abundant scope for new discovery on a large scale.

Dr. Tiratsoo covers the same general ground in his description of the oilfields of the world, but giving less space to the United States and more to Europe and Asia with good illustrative maps and cross-sections. His geological time-chart which precedes this chapter is somewhat unsatisfying in that he accepts Hang's classification for Europe as the standard, and for North America he omits most of the stage names which cause so much confusion to European geologists. He shows the Permian as an epoch of the Carboniferous period, which is unusual in American practice. There is no discussion of reserves on the lines of that in Prof. Landes's book, which is perhaps a weakness.

Either of these books may be confidently recommended for a general survey of the subject, with a great concentration of up-to-date facts. The criticisms stated above are not meant to imply that they are not both good books, but only to express a slight disappointment that they are not better.

ROBERTS'S "HEAT AND THERMODYNAMICS"

Heat and Thermodynamics

By Dr. J. K. Roberts. Revised by Dr. A. R. Miller. Fourth edition. Pp. xx+593. (London and Glasgow: Blackie and Son, Ltd., 1951.) 35*s*. net.

NOTABLE advances in low-temperature work and in the theory of the solid state have taken place during the eleven years since the last edition of the late Dr. J. K. Roberts's "Heat and Thermodynamics" appeared. The new material incorporated in this, the fourth edition, by Dr. A. R. Miller, brings the book up to date with discussions of experimental work published as recently as 1950. The time was ripe for a new edition—not that such a book could ever be 'out of date', but simply because new problems have afforded such excellent examples of the application of thermodynamics that their study must surely help the reader to a better understanding of the subject as a whole.

Most of the new work is introduced in the chapter on low temperatures, which includes an account of the Collins helium liquefier, Simon and Swenson's investigation of the liquid–solid equilibrium of helium, the helium vapour-pressure scale of temperature below 5° K., a discussion of the theory of cooling

by adiabatic demagnetization, and the problems of relating the magnetic and thermodynamic temperature scales. This chapter really contains the reasons for the major changes made later in the book. For example, the title of the former chapter on "The Nernst Heat Theorem" has been changed to "The Third Law of Thermodynamics". There the evidence accumulated from the study of helium equilibria, superconduction and adiabatic demagnetization is shown to indicate that the entropy difference between the possible states of a system vanishes as the system approaches absolute zero, and to justify the changed status of this theorem.

There is an entirely new chapter on higher-order phase transitions, and here two important cases have been treated as illustrations of a general principle. These are the second-order transitions of liquid helium at its lambda point, and of a metal to the superconducting state. Second-order analogues of the Clausius–Clapeyron equation are first derived from the Gibbs function or its magnetic equivalent, and these are seen to contain the parameters involved, and to be consistent with the observations.

At the end of the chapter on the second law of thermodynamics, Carathéodory's principle is mentioned as the logical basis of the analytical treatment of the second law. It is proper that the student should be made to consider whether the concept of entropy, introduced via one-component systems operating Carnot cycles, is, in fact, applicable to systems with more than one component. It appears that the principle, which justifies this generalization, follows at once from Joule's experiments, as the text states; but it might have been well to add a few lines of explanation at this point, since the student's real difficulty often lies in the step between experiment and analysis.

In devoting himself to the revision of this indispensable book, Dr. Miller has done a valuable piece of work; and the publishers and printers must be congratulated on a standard of production which matches the excellence of the earlier editions.

G. R. Noakes

A PHOTOGRAPHER IN THE ANTARCTIC

Antarctic Isle: Wild Life in South Georgia
By Niall Rankin. Pp. 383+138 plates. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1951.) 25*s*. net.

NIALL RANKIN in his earlier book, "British Divers", set a high standard for his following works, and he has now written a book which will be prized alike by the scientific-minded and the non-scientific-minded of his readers. This time he takes his reader far afield, to his "Antarctic Isle". From his home in the Isle of Mull, Colonel Rankin made an ambitious expedition to South Georgia, his small vessel being a converted Royal National Lifeboat, 42 ft. long and of 11 ft. beam, which was carried to South Georgia on the deck of a large 23,000-ton vessel used as a floating whale factory. The other members of the crew were two young Shetland seamen. South Georgia, 100 miles in length and 30 in breadth, is the sea-bird lover's paradise, and Colonel Rankin's remarkable photographs bring the island vividly before the reader's mind. Although bird life is so plentiful, there are in South Georgia only three phanerogamic plants—a small Antarctic buttercup (*Ranunculus biternatus*), a bedstraw (*Galium antarcticum*) and two burnets, the larger of the two (*Acæna ascendens*) being peculiar to South Georgia.

One of the most arresting chapters in the book is that on the wandering albatross, a great bird with a wing span approaching 11 ft. and a weight up to 27 lb. At a colony of these birds, Colonel Rankin made valuable observations. He believed the incubation period to be 70–73 days. Six days elapsed between the first chipping of one egg and the hatching of the bird. The young albatrosses (they remain in the nest, still in down, throughout the whole of their first winter) were regularly weighed. One at birth was 13 oz.; at the end of a week it was 22 oz., at 22 days 4 lb. 4 oz., and at 31 days 6 lb. 11 oz. The author gives the record of a wandering albatross's flight of no fewer than 3,150 nautical miles in 12 days.

This book combines good writing with outstanding photography. Many of the observations on the birds of South Georgia are new, and the account of the courtship of the wandering albatross is a piece of remarkably descriptive writing. Colonel Rankin was unsuccessful in his efforts to discover the egg of the snow petrel, but there is (p. 270) a fine account of the masterly flight of this, the most hardy of Antarctic petrels. Birds occupy only a part of the book. There are chapters on the whales and the seals, and the author does well to re-tell Sir Ernest Shackleton's epic voyage with five companions in an open boat from Elephant Island to South Georgia over more than eight hundred miles away through tempestuous seas and in bitter cold. That voyage was one of the most hazardous ever successfully undertaken by man, and at its close the tired men had to make a crossing (the only one ever made) of the snowy heights of South Georgia to reach the sealing station there.

The photographs which illustrate this book are of so high a standard that it is difficult to single out any for special praise. To my mind, those showing the courtship display of the wandering albatross and that of Wilson's petrels in flight are perhaps the best. Of the photographs of scenery (one shows a 9,000-ft. peak untrodden by the foot of man), the most remarkable is that (plate 107) showing a gust of wind estimated at 115 miles an hour on the point of reaching the author's craft at anchor. Colonel Rankin was ashore at the time, and took the photograph crouching on all fours. He tells us that he feared his craft was doomed.

Seton Gordon

BIRDS OF GREENLAND

Grønlands Fugle (The Birds of Greenland)
Text by Finn Salomonsen; plates by Gitz-Johansen. Part 2. Pp. 159–348+19 plates. (København: Ejnar Munksgaard, 1951.) 66*s*.; 9 dollars.

THE second part of this useful work deals with the ptarmigan, wading birds, skuas and gulls. The ptarmigan is very common and is treated in great detail, and there are new and interesting observations. Dr. F. Salomonsen recognizes three races in Greenland which are found from sea-level to the ice-cap and as far as lat. 82° 46′ N., where Captain Feilden, naturalist in the *Alert*, collected a specimen in 1876 and on the label wrote "The northernmost bird ever collected by man". Though this record still holds good for the ptarmigan, a turnstone and a long-tailed

skua have been taken a little farther north in lat. 83° 7′ N.

After the breeding season there is a general tendency for ptarmigan, which have nested in the higher parts of the interior, to move down towards the coast, but this movement depends to a great extent on the snowfall. In the peak years, however, there is a well-marked north-to-south migration in vast packs, and a bird ringed in July 1949 on Disko Island was recovered in the following February at Julianehåb, 1,000 km. to the south. At Godhavn in 1949 all the ptarmigan shot there during the winter were males, and when packs from the south appeared in the early spring they too were males, to be followed early in May by packs of females. In these peak years the number of birds which migrate to the south is enormous, and vast numbers are killed for food. Dr. Salomonsen has much of interest to tell of the food and habits of the ptarmigan, and he mentions that in winter the birds roost at night under the lee of a rock in a crevice or in a hole 20 cm. deep dug into the snow by the bird itself.

Of the fourteen different forms of wading birds which occur in Greenland, ten are known to breed, and they include the knot, the eggs of which were such a prize to egg collectors in the early part of the present century. Both the European and American golden plovers visit the country in spring and autumn, but so far none has remained to breed, and most of the birds shot in the autumn are young of the year. The Iceland form of the whimbrel is likewise a spring and autumn visitor, and Dr. Salomonsen considers that both the European golden plover and whimbrel, which reach Greenland in the spring, have been blown out of their course when migrating from the British Isles to Iceland. This, however, can scarcely be the case in the autumn.

The skuas and gulls comprise eleven species and include that rare and beautiful bird, Ross's gull, which has occurred on eighteen occasions in the spring on the west coast of Greenland. This gull nests in eastern Siberia, but Dr. Salomonsen suggests that there may be a colony on some of the Canadian Arctic islands, as some of the birds shot in Greenland were in breeding condition. There is a single record of Ross's gull nesting among a colony of terns near Disko Bay in 1885. Two eggs were laid and the birds shot, but doubt has been cast on the authenticity of the eggs, one of which is now in Copenhagen and the skin of one of the parent birds in the British Museum. Dr. Salomonsen considers this record is correct, and there is reason to think he is right.

N. B. KINNEAR

STATISTICS AND MENTAL TESTS

Theory of Mental Tests

By Prof. Harold Gulliksen. (Wiley Publications in Psychology.) Pp. xix+486. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 48*s*. net.

IF that old friend and inveterate sightseer, the visitor from Mars, were informed that a large, learned and modern book on the theory of mental tests contained not one word about the nature of intelligence, aptitude, intellectual processes or indeed any other attribute of the human mind, he might be surprised. The present reviewer, who does not come from Mars, is not so much surprised as resigned. These things are signs of the times. After the innumerable and fruitless discussions, arguments and effusions occasioned by the problems of intelligence and aptitude, there has been some reaction towards the firmer ground of statistical methodology. Statistics has always played a large part in mental testing; but one might be inclined to wonder whether the servant is not in a fair way to becoming the master. That is perhaps an exaggeration; it would be fairer to say that Prof. H. Gulliksen has made a special study of this aspect—what may be called the mathematical theory of testing the test. A book on the theory of structures will tell you how to calculate the strength of any given structure, but it will not, except in a few simple cases, tell you how to design a structure for any given job; that is for your ingenuity. There is some justification for taking the same attitude to mental test theory; at any rate, it is clearly the attitude that Prof. Gulliksen does take.

As a text-book on statistics applied to a special field, the book certainly covers a great deal of ground. The student will find that he needs some initial help in grasping the basic ideas of probability distributions, sampling errors, and the jargon of correlations, covariances, etc., and that then the earlier chapters are rather long-winded. The author seems to be straining (commendably) after a simplicity of presentation which he never quite attains. A number of "computing diagrams"—families of curves of various commonly-occurring functions—are given, with the suggestion that the student should reproduce them to a large scale. Some of them will undoubtedly be useful, but it seems unlikely that many people will take the trouble to use a chart when they have to add two variances together.

One of the basic concepts used by the author is that of parallel tests. These, though differing in detail, are defined as being statistically indistinguishable, so that "it does not matter which test you use". Parallel tests should give, in the long run, equal means and variances, and should have equal reliabilities. They should also have approximately equal validities for any given criterion. The validity of a test is its predictive value, as measured by the correlation of the scores with, say, scholastic achievement. It is not immediately obvious why the author adds that parallel tests, in addition to satisfying statistical criteria, should contain items dealing with the same subject-matter and having the same format—in other words, that they "should be parallel as far as psychological judgment is concerned". The explanation that springs to mind—if one rejects the obvious 'sop to Cerberus' and 'insurance policy' hypotheses—is that the statistical criteria are not adequate. But it is hard to see any fundamental reason why they could not be made so.

Among the topics dealt with, mostly in terms of this concept of parallel tests, are errors of measurement and prediction, effects of test-length, group heterogeneity, "speed" and "power" tests, and problems of standardizing and weighting, etc. Oddly enough, there is no section dealing explicitly with factor analysis, although the procedure is mentioned here and there in various connexions. This is doubtless no accident, but probably the result of a general veering towards a more empirical and perhaps more fundamental approach. A large number of exercises for students are included, as well as an appendix on elementary algebraic and other formulæ. Taking it as a whole, this is a book for the specialist, in all his metamorphoses from egg to imago. W. E. HICK

Addendum 1951 to the British Pharmacopœia 1948

(Published under the direction of the General Medical Council.) Official from September 1, 1951. Pp. xviii+114. (London: Constable and Co., Ltd., 1951.) 17*s*. 6*d*. net.

THE rapid advance of pharmacology makes it essential that the pharmacopœias of the world shall be published more frequently than before. It is hoped that the "British Pharmacopœia" will now be published at intervals of five years; but even this is not enough, and it will probably always be necessary to publish addenda to bring the old Pharmacopœia up to date while the new one is coming to birth. The 1951 addendum to the "British Pharmacopœia" contains fifty-two new monographs dealing with such substances as chloramphenicol, dicophane (DDT), dihydrostreptomycin, dimercaprol (BAL), mepyramine (neoantergan), oxophenarsine, proguanil ('Paludrine'), quinalbarbitone (seconal), sulphadimidine (sulphadimethylpyrimidine), tubocurarine, and various vaccines and preparations of human blood.

One of the most important duties of the Pharmacopœia Commission is to devise official names for new drugs. The fruits of its work in this field generally appear first as "Approved Names" for unofficial drugs, which are eventually admitted to the Pharmacopœia itself. The choice of names is complicated by the desirability of keeping in step with the Americans, who are engaged upon the same pursuit, and is sometimes limited by the fact that a number of manufacturers have chosen all the best names and taken legal action to prevent other people using them. These are some of the difficulties; the result is not uniformly successful. The Commission was in happy mood when it approved of 'sulphadimidine', but it is unfortunate that it was driven to approve of 'tripelennamine', which is too long and presumably owes its origin to the unspecific fact that its full chemical name contains the letter 'n' repeated three times (if not four). The teachers of pharmacology must learn these new names themselves, teach them to their students, and persuade their clinical colleagues to use them instead of the confusing collection of seductive trade names, many of which refer to the same substance. The ease with which these various tasks can be accomplished depends on the success of the Commission in choosing official names which are euphonious and brief. Each new list of approved names is received with mixed emotions by those who will have to use them.

J. H. G.

Moderne Biologie

Festschrift zum 60 Geburtstag von Prof. Dr. Hans Nachtsheim. Herausgegeben von H. Grüneberg und W. Ulrich. Pp. 288+5 plates. (Berlin: F. W. Peters, 1950.) n.p.

THIS volume, edited by H. Grüneberg of London and W. Ulrich of Berlin-Dahlem, is the "Festschrift" marking the sixtieth birthday of Prof. Hans Nachtsheim, the distinguished German geneticist who is now professor of general biology and genetics and director of the Institute of Genetics of the Free University of Berlin (necessarily in the Western and not the Eastern Zone of that city). The introductory chapter by Ulrich tells of Prof. Nachtsheim's career and of the importance of his work, which began with a paper in 1912 on the cytology of sex determination in the honey bee, and continued with a long series of one hundred papers on the genetics and physiology of a wide range of organisms—principally *Drosophila*, the rabbit, the pig, man himself, and an extraordinarily wide array of other material. His latest paper concerns the Pelger-anomaly in man and rabbit—a Mendelian character of the nuclei of the leucocytes—and was published in 1950 in the *Journal of Heredity*.

The contributed papers are twenty in number, and, as is to be expected, contain authoritative accounts of the recent work of many writers, principally but not exclusively German, whose works are not easily accessible in Great Britain. A wide range of biological territory is covered in developmental genetics, general zoology, anthropology, animal psychology and evolution. In works of this nature it is scarcely possible to single out many individual contributions for special comment. Those interested in modern aspects of evolution will welcome Sewall Wright's essay "Population Structure as a Factor in Evolution", which summarizes his more recent ideas. Of importance to animal psychologists is the paper by K. Herter, "Vom Lernvermögen der Fische". The genetical basis of polyembryony in plants is of great practical significance to plant breeders, and is discussed by H. Kappert.

As a book of both general and special biological interest, this is a noteworthy addition to recent biological literature.

S. C. Harland

Advances in Electronics

Edited by L. Marton. Vol. 2. Pp. x+378. (New York: Academic Press, Inc., 1950.) 7.60 dollars.

THE second of what is apparently intended to be an annual series, this book presents a number of review articles by both American and European authors. The topics covered are as follows: progress in the past decade in the manufacture and design of cathode ray tubes; electron lenses; field plotting and ray tracing in electron optics; cathodoluminescence; intrinsic dielectric breakdown in solids; the microwave magnetron; ferromagnetic phenomena at microwave frequencies; and microwave spectroscopy. All the articles are of a high standard and form useful surveys of the present state of knowledge in their respective fields.

Electron-Tube Circuits

By Prof. Samuel Seely. (McGraw-Hill Electrical and Electronic Engineering Series.) Pp. ix+529. (New York and London: McGraw-Hill Book Co., Inc., 1950.) 57*s*.

THIS volume forms one of the McGraw-Hill Electrical and Electronic Engineering Series; and, as the author states, it is the outgrowth of several courses, organized by him, on electron-tube circuits and applications covering many important types of equipment and instruments in widespread use during the Second World War.

The subject-matter falls into a number of major sections. The first of these is a review of the fundamental properties of electron tubes and their basic circuit applications. The second part of the book contains a discussion of untuned amplifiers and circuits, including a chapter on arrangements which are particularly important in analogue computers, while the third part deals similarly with tuned amplifiers and oscillators. Next there is a comprehensive treatment of power rectifiers, filters and regulators, which is followed by a discussion of amplitude modulation and demodulation and frequency modulation and detection. Finally, there is a section on circuits of a kind developed extensively during the War for use in

radar; this includes relaxation oscillators and sweep generators.

The book is written in a clear style and is liberally illustrated, and a number of problems have been included at the end of each chapter. It should provide a useful text for students in electrical engineering.

J. A. SAXTON

Nandi Work and Culture

By G. W. B. Huntingford. (Colonial Research Studies No. 4.) Pp. iv+126. (London: H.M. Stationery Office, 1950.) 8*s*. 6*d*. net.

THIS is a typescript copy of six chapters from a report written in 1947–48 for the Kenya Government on the Nandi, a subdivision of the Nilo-Hamitic group of tribes of Kenya and Uganda Colonies. This study deals respectively with Nandi traditional history, with their topography and population statistics, their cattle culture, their economic activities, their culture contacts with their neighbours, and with some of the culture conflicts brought about by colonial rule. The rest of the report dealing with the social and political life of the Nandi will be published elsewhere under private auspices.

This study is a mine of information on both practical administrative problems like building footbridges of local materials, or local cattle diseases, and on more obviously ethnological matters. These range from "Azanian" remains, cattle horn shapes and the native names for them, the Kaptich system of cattle distribution between relatives, to comparison between Kavirondo and Nandi agricultural implements or between old and new types of Masai and Nandi spears.

There are no less than five excellent maps, twenty-two clear and well-drawn figures in the text, the paragraphs are numbered consecutively from 1 to 315 and there is a good index with paragraph references. Would that all anthropological monographs were presented in such a clear and direct form.

The Colonial Office states in an introductory note that the publication is of a private character, the views expressed being those of the author and not of any government authority.

G. I. JONES

The Design of Experiments

By Prof. Ronald A. Fisher. Sixth edition. Pp. xv+244. (Edinburgh and London: Oliver and Boyd, Ltd., 1951.) 12*s*. 6*d*. net.

IN 1935, when "The Design of Experiments" was first published, statistical text-books gave scant attention to questions concerning the design of a scientific inquiry: performing calculations appropriate to data placed before him was regarded as a statistician's sole duty. To-day, every book on the scientific applications of statistics gives prominence to the design of experiments and sampling inquiries: the statistician's contribution to the design of an investigation is recognized as often far more important than his function in analysis. This change is largely due to the influence of R. A. Fisher's work.

Now that several systematic treatises on experimental design exist, why should this pioneering book continue to be issued substantially unchanged? (The sixth edition differs from the fifth only by the addition of a few paragraphs explaining more clearly the use of interactions in estimating error variances.) The answer: Just because Fisher is not tied to a systematic development, he is able to give by far the most stimulating introduction to design and its relationship with the whole corpus of applied statistics. Despite a style of presentation that is seldom found easy by a novice, his book is a remarkable aid to the understanding of the basic principles of design. Moreover, even paragraphs that were written for the first edition are pregnant with ideas for the future: for example, in most fields of science, too little attention has yet been given to that cost accountancy of experiments (in relation to the quantity of information obtained) which Fisher believes capable of enormously increasing the efficiency of research programmes. In 1935, he stated that immense waste of resources in futile experimentation had resulted from failure to utilize past experience in order to assess the precision attainable in future experiments; that statement is repeated in 1951, and, if still true, is a reflexion of the extent to which the lessons of this book have still to be learnt.

D. J. FINNEY

Ireland

Its Physical, Historical, Social and Economic Geography. By T. W. Freeman. Pp. xv+555+16 plates. (London: Methuen and Co., Ltd.; New York: E. P. Dutton and Co., Inc., 1950.) 32*s*. 6*d*. net.

PROBABLY no book on Ireland has previously been written on this scale. It is so searching in its array of facts that one wonders if anything of importance can have escaped notice. The industry demanded in its compilation has been great, and the result is a voluminous and worthy work of reference, but not an exceptionally readable one. The first half treats of the distribution of features in Ireland as a whole, while the second half is detailed regional geography of the twelve major regions and the approximately ninety sub-regions. It is here, perhaps, that the survey is a little too discursive. The boundaries of many of these divisions are often difficult to define, and attempts to draw them give a false insistency on the individuality of the region. The author, however, is aware of this difficulty. There is also a long section on the historical geography of Ireland. The bibliographies attached to every chapter are exhaustive, and there are about a hundred text maps. The long index with its lack of classification under each entry is practically useless.

R. N. R. B.

Science in the School Garden

By Mary A. Johnstone. Pp. xiv+176. (London: Macmillan and Co., Ltd., 1951.) 4*s*. 6*d*. net.

MOST of the many gardening books which appear each year are badly written and based upon the prejudiced impressions of someone with a wealth of so-called practical experience which proves to have little general application because of the limited character of its observation. It is a pleasure, therefore, to recommend Miss Johnstone's little book, which might more appropriately have been called "Gardening, from a Scientific Point of View". The work is a careful mixture of the author's own gardening observation together with objective accounts of plant structure and physiology, the work of insects, simple soil science, and the ecology of gardens. Emphasis is always placed upon the need for experiment and investigation so that none of the traditional gardening beliefs may be accepted without challenge. Of the many useful chapters one on the gardener and the weather is specially commendable. So, too, is the last chapter which, under the intriguing title of "Odds and Ends", presents the reader with some useful advice on issues which can be irritating to the novice gardener. The book is well illustrated and the line-drawings are clear and illuminating. It should be welcomed by gardening scholars of all ages.

T. H. H.

VOYAGE OF THE *DISCOVERY II*

By Dr. N. A. MACKINTOSH, C.B.E.

THE arrival at Plymouth on December 6 of the Royal Research Ship *Discovery II* marked the completion of a twenty-month voyage of oceanographical survey. It was her first voyage under the auspices of the National Institute of Oceanography, which was founded two years ago to do basic research in oceanography, and which was charged with continuing part of the work of the Discovery Committee. The purpose of this voyage was to round off the Committee's oceanographical work in the Southern Ocean, which in certain respects was incomplete. The *Discovery II* has made five previous voyages to this Ocean with the main purpose of studying the environmental factors which influence the distribution and movements of whales and other marine fauna; and the satisfactory execution of the work, which began in the Falkland Islands Dependencies, entailed a comprehensive oceanographical survey of the whole Southern Ocean. Coastal surveys were made by the ship's officers as opportunities occurred in intervals between the scientific work. The pages of the "Antarctic Pilot" bear frequent references to their observations, and the charts of the Dependencies are based largely on them.

The recent, post-war voyage was planned and timed so that observations could be made in regions and seasons of the year not sufficiently covered by the data collected before the Second World War. The Indian Ocean sector was visited in winter and summer, the Australian sector in autumn and winter, and the Pacific sector in spring and winter; and a winter cruise was made across the Atlantic sector. It was not the first time the ship had contended with cold, bad weather and short hours of daylight during winter months in high latitudes; but during this voyage the difficulties were somewhat increased through most of the ship's personnel being new to the work, and by the occasional appearance of defects for which the ship's arduous service during the war years was probably responsible. All the essential items in the programme were, however, carried out, and many gaps in the previous work have been filled.

The Southern Ocean is a continuous belt of deep water encircling a central land mass; in consequence the prevailing currents and water circulation, and the fauna and flora, are distributed in a simpler pattern than in other oceans, and they are particularly suitable for a study of the large-scale physical, chemical and biological processes. It is an advantage also that there are comparatively few species in the rich fauna and flora. The relative simplicity of the water conditions allows useful generalizations to be made from fewer data than in other oceans, and make this region an ideal laboratory in which to formulate and test basic principles for use in other parts of the world. Such work will necessarily take a long time. The newly supplemented data will also be used for the more pedestrian task of compiling in some form an oceanographical atlas of the Southern Ocean, including charts, not only of surface temperature and ice conditions south of the usual tracks of shipping, but also of all the major oceanographical features of the Southern Ocean. Such charts enable the whole region to be seen in perspective, and they are needed as a basis for the further study of the extensive biological data and collections. They are also required for examining the interchange of energy between the ocean and atmosphere, which is one of the most promising lines of marine physical investigation, and one which will improve our understanding of antarctic climatology and weather.

In spite of the circumpolar continuity of phenomena in the Southern Ocean, some sectors are more productive than others, and it will be necessary to examine carefully the connexion between such variations in the richness of animal and plant life, and variations in the strength of the water circulation and the movements and properties of the main water masses. This problem is bound up with the circulation of the plankton, which maintains an endemic population in the antarctic zone through interchange between the surface layer which drifts northwards and the underlying 'warm deep water' with a compensating drift to the south. Many of the commoner species of the zooplankton spend the summer in the surface layer and are carried back to high latitudes in winter in the deeper layer; others move from one to the other in their diurnal vertical migrations. The krill (*Euphausia superba*), which is the staple food of whales, and of many seals, birds and fish, lives close to the surface, but its eggs are hatched at depths probably exceeding 1,500 m.; the larvæ pass through several stages as they rise through the southward drift to replenish the stock at the surface in high latitudes. Recent work has shown also that the drift from the Weddell Sea is the principal nursery of the krill. Thus the texture of the pelagic populations is beginning to be understood; but much painstaking work will yet be needed to relate the regional differences in the distribution and life-histories of such organisms with the distribution and habits of whales.

A detailed knowledge of the bottom topography of the ocean is essential to a full understanding of the water circulation, and during the recent voyage the *Discovery II* has supplemented her earlier depth charts by an enormous number of new echo-soundings, and has recorded many continuous bottom profiles, running the sounding machine for long periods. Information on the depths of bottom sediments was also obtained in a number of places by seismic echo soundings with 1¼-lb. explosive charges. Four long bottom cores were obtained in the Indian Ocean with a Kullenberg corer. South of Australia, the corer struck a hard substance—possibly a meteorite—on the bottom; the nose-piece was blocked with hard brownish-black material which had to be chipped out. It was handed to the Geological Department of the University of Western Australia for further examination.

A good deal of work was done for the Governments of Australia and New Zealand, which are represented on the National Oceanographic Council and contribute to the finances of the National Institute of Oceanography. Lines of physical and biological observations were made off the coast of New South Wales and in the Australian Bight for the Fisheries

Division of the Commonwealth Scientific and Industrial Research Organization, and a number of dredgings off the west coast of Australia for the University of Western Australia. Sounding and dredging were carried out in the Tasman Sea and south-east of New Zealand for the New Zealand Department of Scientific and Industrial Research. A number of Australian and New Zealand scientific workers were carried from time to time and given facilities on the ship, and one Australian biologist, Mr. E. H. M. Ealey, made the whole circumpolar voyage. Help was given to the stations of the Australian National Antarctic Research Expedition on Macquarie and Heard Islands. Stores were landed at Kerguelen for a French expedition, and diesel fuel at Heard Island.

Certain special investigations were included in the programme. One of these was concerned with the Antarctic Convergence, a region of sudden increase in surface temperature between antarctic and sub-antarctic water masses. This must now be regarded as similar to an atmospheric 'front' in which unstable waves grow into cyclones and anticyclones; but the new observations, while providing evidence of the eddies associated with such frontal developments, gave further indications that the mean position of the convergence remains remarkably constant.

Regular observations on birds made by the Third Officer, Mr. G. H. Selby-Smith, confirm the tendency of all pelagic life in the Southern Ocean to be distributed in circumpolar zones.

In addition to the main survey of the Southern Ocean, observations have been made and repeated along the 90th E. meridian, through the central part of the Indian Ocean, about which there is little other oceanographical information except for a few recent and very useful observations by the French antarctic research vessel, *Commandant Charcot*. Lines of observations were made also from the Red Sea to the Indian Ocean during June 1950 and in the opposite direction during November 1951. The vertical sections indicate a larger submarine outflow in winter than in summer, but they emphasize the great irregularity of the bottom topography of the region, which makes quantitative comparison difficult. A line of stations was also worked through the Straits of Gibraltar.

During the twenty-month voyage of the *Discovery II*, Cdr. J. F. Blackburn was in executive command, and the principal scientific officer in charge of the work was Dr. H. F. P. Herdman.

For the next year or two, while the results of the recent voyage are being analysed, the vessel will be employed mainly in research work aimed at furthering our understanding of some of the basic processes which affect the physical conditions and life in the sea. On the physical side, much of the effort will be devoted to studying the processes by which energy is exchanged between the sea and atmosphere, and transported from one area to another or exchanged between shallow and deep layers. It is hoped that a good deal will be done which is of direct interest to all oceanographers, and to save time and expense it will be done as near to the United Kingdom as the conditions most favourable for the experiments can be found. On the biological side, it is expected that much of the effort will be devoted to testing new methods of sampling, and to the study of the habits of some pelagic and bottom-living animals in relation to water conditions, nature and slope of the bottom, and other factors.

FORESTRY IN GREAT BRITAIN

REPORT FOR THE YEAR 1949–50

TWO reports dealing with forestry in Great Britain during the year 1949–50 have been issued by the Forestry Commissioners: the first is the thirty-first annual report of the Commissioners* and the other is an account of forest research that took place during the year†. In their annual report the Commissioners were able to record that agreement had been reached with the representatives of private woodland owners with regard to the conditions under which landowners can dedicate their woodlands to the production of timber and manage them according to a plan of operations satisfactory to the Commissioners, in return for which they receive certain financial aid from the Government. Objections to details in the contract of dedication had hitherto prevented the landowners' and forestry societies from recommending their members to come into the scheme, and the progress of dedication had been disappointingly slow. Now that these objections have been met, it is hoped that more rapid progress will be made. During the year the response was already apparent in an increase, from 248 to 374, in the number of estates engaged in preparing plans for the effective management of their woodlands. Further encouragement to private forestry has been given by increasing the planting and maintenance grants and by giving support and encouragement to co-operative associations of small woodland owners for mutual help in managing their woods and marketing their produce. In spite of all efforts to bring about the rehabilitation of the 813,000 acres of woodlands classified as felled or devastated in the Census of Woodlands for 1947, most of which are privately owned, progress is distressingly slow, and the Commissioners feel that, unless there is a considerable improvement within a reasonable time in the rate at which private owners bring their woods into satisfactory production, they will have no option but to use their compulsory powers of acquisition.

Progress in the Commission's work of extending and managing the State forests has continued. The area of land acquired during the year was 109,000 acres, of which 61,000 were classified as "plantable". This brought the total area of land acquired by the Commission to 1,004,000 acres of "forest land and 664,000 acres of other land", which includes forest nurseries, agricultural and grazing land, and other land unsuitable for planting. During the year, 53,737 acres were planted—an increase of about 10,000 acres on that planted in the previous year. The area thinned was 31,996 acres, and the area clear-felled 1,221 acres. Grants amounting to £12,436 were made to various universities for educational purposes, and five training schools for foresters were maintained by the Commissioners.

A brief account of the research and experimental work carried out or sponsored by the Commissioners is given in their annual report; but a fuller one appears in the separate report on forest research. This latter is divided into two sections, the first dealing with the work carried out by members of the staff of the Forestry Commission, and the second with work on

* Forestry Commission. Thirty-first Annual Report of the Forestry Commissioners for the Year ending September 30, 1950. Pp. 75. (London: H.M. Stationery Office, 1951.) 2s. 6d. net.

† Forestry Commission. Report on Forest Research for the Year ending March 1950. Pp. 126. (London: H.M. Stationery Office, 1951.) 3s. 6d. net.

special problems undertaken for the Commission by universities and other institutions.

Much of the work of the Commission's own research branch is devoted to the trying out of various treatments and techniques on the growth of seedlings and young plants in the nursery and in the forest. Some of the more fundamental problems in connexion with such treatments are dealt with by workers in various institutions. An example of this is the effect of partial sterilization of the soil of established nurseries on the growth and survival of seedlings. It has been found that the residual effects of sterilization by steam and by formalin in the previous year are marked, and experiments are being made with the view of improving the methods of applying formalin to improve the effectiveness of the chemical. J. H. Warcup, of the Botany School, Cambridge, presents some interesting results of the effect of partial sterilization by steam and formalin on the fungal population of the soil at Ampthill Nursery, Bedfordshire, where the response of sitka spruce seedlings to sterilization was very large. Before sterilization, the soils were found to contain more than a hundred species of fungi. In the steamed plots all fungi were killed down to a depth of about twelve inches, and in the formalin plots down to four to six inches. Re-infection started from the surface in about six weeks in the steamed plots and nine weeks in the formalin plots. Re-infection was mainly by *Trichoderma viride* in the formalin plots. In the steamed plots, *Trichoderma* was the commonest species to reappear, with *Mortierella* and *Coniothyrium* as associates.

A very interesting section of the report is that on forest genetics, by the Commission's geneticist, J. D. Matthews. The ultimate object of the work is, of course, to provide British foresters with supplies of seed which will produce trees of desirable qualities, whether in form, resistance to disease or insect attack, vigour of growth, etc. This is a long-term project which is divided into three stages in its progress towards complete control of parentage. The first step is mass selection. The best stands in the country are being listed by means of the Census of Woodlands for 1947. The older woods are regarded as safe sources of seed, after the obviously bad trees are removed. Younger woods of unknown origin will be tested by observations on plantations formed of their progeny. By this method the parent trees are known only in mass. The second stage is the selection of mother trees. Vigorous and well-formed mother trees have been selected in the best of the older woodlands and plantations, and seed will be gathered from them during several successive years. The progeny will then be tested against a standard race, and 'seed plantations' will be formed from offspring of the best parents. The mother trees are now known, while the fathers are unknown. The third stage is the testing out of outstanding phenotypes by vegetative propagation and controlled pollination. The trees with outstanding genotypic constitution will be included in a series of 'seed orchards' and treated for regular seed production in a similar manner to fruit orchards. Both male and female parents are now of known value. In the report, the progress made with each of the important species used in British forestry is described, and mention is also made of experiments to improve the technique of vegetative propagation. Testing of kinds of stocks and scions for grafting different species, the use of various growth substances to promote the rooting of cuttings, etc., and the search for methods of hastening seed bearing are all receiving attention.

In the section on forest ecology, by J. M. B. Brown, four outstanding beech forests in England are described, with special reference to the natural regeneration. Exposure to wind, which removes the litter and dries the surface soil, hinders or prevents beech regeneration; and generally speaking, regeneration in large gaps is poor or absent, while in smaller openings it is successful. It is clear, from these and other beech woods, that good beech can be grown in Britain under widely different conditions, and one of the conclusions reached is that the *p*H of the soil is, of itself, not a decisive factor. Of eighteen of the finest stands of beech in Britain with mean top heights of 100 ft. or more, three were definitely on soils with a *p*H less than 4·9 (class 1); two more were in the same class of *p*H but on the border-line of the next class; one was in class 2 (*p*H 4·5–5·9); eight in class 3 (*p*H 6·0–7·9); and four in class 4 (*p*H more than 8). Attention is, however, directed to the possibility that the influence of the beech canopy on the soil over a period of a hundred and fifty years or more may have caused changes, so that it cannot be assumed that the present *p*H of the soil represents the condition in which the forest actually grew up.

It is impossible to mention all the different subjects covered by the report dealing with forest research; it is especially valuable to forestry workers, but some topics are of interest to biologists and soil scientists generally. In general, the report is valuable because it mentions many of the problems and difficulties with which the British forester is faced and the steps which are being taken to deal with them by sylviculturists, engineers, economists and scientific workers in various fields.

T. Thomson

ISOTOPES IN MICROBIOLOGY

Under the chairmanship of Dr. A. J. Amos, the Microbiology Group of the Society of Chemical Industry organized a symposium on "Isotopes in Microbiology" which was held at the Institution of Structural Engineers, London, on October 10. In an effort to present the possibilities of tracer technique to those working in both the industrial and academic fields, the papers covered a wide range, from general reviews of the technique and its results to specialized accounts of individual research problems.

Dr. J. C. Boursnell opened the meeting with a paper on "General Aspects of the Use of Radioactive Isotopes in Biology". Starting from an elementary treatment of the physics and chemistry of radioisotopes, emphasis was laid on the practical consequences of these facts: on the importance of paying attention to counter geometry and its reproducibility, and on the effects of sample thickness when working with soft β-emitters such as sulphur-35 and carbon-14. So far as precautions against radioactive hazards are concerned, he said there is much to be gained by working rapidly and at a distance from the sample as well as by adequate screening.

Dr. R. Davies reviewed "The Applications of Radioisotopes in Microbiological Chemistry", illustrating the technique of identifying intermediate compounds and of estimating the order of their appearance in a sequence by reference to the work of Calvin and Gaffron on carbon dioxide fixation by *Scenedesmus*, and to that of Burris and Wilson on

nitrogen fixation. The studies by Spiegelman on phosphate turnover in the nucleoprotein fraction of yeast during growth, but not during glycolysis, were commented upon, followed by a more extensive consideration of reaction systems in equilibrium.

The simple picture of equivalence of specific activity among the labelled reactive groups participating in a reversible reaction at equilibrium may break down not only in cases where too little time is allowed to achieve equilibrium, but also where alternative reaction routes exist, where the isotope is transferred by some other reaction, or where the system for the reverse reaction is not complete. An excellent example of such difficulties is provided by the studies of Wood, Werkman *et al.* on the phosphorylative decomposition of pyruvic acid into formic acid by *E. coli*. The reaction

$$CH_3CO.COOH + H_3PO_4CH_2 \rightarrow COO.PO_3H_2 + H.COOH$$

is apparently reversible if judged by the attainment of equal specific activity in the carbon-14-labelled carboxyl groups, but added carbon-13-labelled acetyl phosphate shows no interchange with the methyl or carboxyl groups of the pyruvic acid. This can be explained if the reaction proceeds in two steps under the control of two different enzymes, E_1 and E_2:

$$CH_3CO.COOH + (CoA).E_1 \rightleftharpoons CH_3CO.(CoA)E_1 + HCOOH \quad (1)$$

$$CH_3CO.(CoA)E_1 + E_2 \rightleftharpoons CH_3CO(CoA)E_2 + E_1 \quad (2)$$

$$CH_3CO(CoA)E_2 + H_3PO_4 \rightarrow CH_3COO.PO_3H_2 + CoA + E_2. \quad (3)$$

The coenzyme, CoA, is assumed to be present in all three reactions with appropriate changes in its state of oxidation-reduction.

Results are often misleading where they involve exchange across a cell membrane, as with the slow incorporation of phosphorus-32 into stimulated muscle (Sachs) as compared with its rapid exchange in muscle extracts; in the intact muscle the concentration of the internal inorganic phosphorus-32 is the important factor in limiting the uptake. Isotope dilution methods, if applied by adding unlabelled carrier intermediates to an intact cell suspension, are particularly prone to error.

Kaufman and Ochoa's work on the decarboxylation of labelled malic acid by *L. arabinosus* is an instructive example of another type of problem. Pyruvate, the intermediate between malate and lactate in this reaction, actually shows less activity than the lactate if unlabelled pyruvate is added to extract the active isotope. Here it appears that exchange between the carrier pyruvate and the enzyme-associated fraction is incomplete; the association persists in large part until the lactate is liberated at the end of the reaction.

Dr. J. L. Harley, working with Mr. C. C. McCready, reported on "The Phosphorus Uptake of Beech Mycorrhiza". An infection of the feeding rootlets by this fungal sheath, with its extensive outgrowing hyphæ, is apparently correlated with more rapid absorption of phosphorus (as well as of nitrogen and potassium) than in normal rootlets. Separation of the fungal sheath from the rootlet core showed that at low external concentrations of labelled phosphate, 90 per cent was retained in the sheath and only 10 per cent passed through into the core. The ratio could be reduced either by reducing the oxygen tension or by increasing the phosphate concentration, both of which favour passage into the core rather than into the sheath. Observations on slices of infected rootlets showed a potentially high rate of absorption of phosphorus-32 into the naked core, and were consistent with the assumption that penetration of phosphate normally takes place through the intercellular spaces of the fungus, which remove the nutrients as they pass. It is evident that there is no foundation for the belief that the infection improves the nutrition of the host by an immediate and direct increase of phosphorus uptake. This, of course, does not preclude a possible secondary effect brought about by the seasonal regression of the nutrient-rich hyphal network.

A detailed study of "The Assimilation of Inorganic Phosphate by *Micrococcus pyogenes* var. *aureus*" was described by Dr. P. D. Mitchell. This work is comparable with that of Spiegelmann on yeast; it represents an attempt to trace the pathways of phosphate radicals in bacterial suspensions. After equilibration with phosphate buffer, the suspensions were provided with added glucose for a period to determine the effect of glycolysis alone, or with glucose plus a casein hydrolysate to produce growth as well. Total and specific activities were determined for acid-soluble (inorganic and organic) fractions, lipid phosphorus, deoxyribonucleic acid and ribonucleic acid fractions as well as for an 'excess phosphate fraction' usually incorporated in and confused with the estimate of the ribonucleic acid. In the initial resting phase, uptake of phosphorus is found to be a one-way process, the phosphorus-32 accumulating in the acid-soluble inorganic fraction. The great increase in activity of this fraction during respiration and growth was ascribed by Dr. Mitchell, not to its high phosphorus turnover, but to its role as a precursor for all other phosphate fractions. From this precursor, acid-soluble organic phosphorus and lipid phosphorus are formed independently, together with a small amount of 'excess phosphate', the last two fractions showing a very small turnover-rate.

In the growth phase, the ribonucleic acid, deoxyribonucleic acid and excess phosphate all showed a considerable increase, the nucleic acid phosphorus passing through the acid-soluble fraction with little or no turnover. The lipid and excess phosphate fractions, on the other hand, show a high turnover in this phase. The rate of increase of deoxyribonucleic acid as compared with that of ribonucleic acid suggests that both must be built up independently from the acid-soluble organic fraction without the possibility of direct interconversion.

Prof. J. E. Harris's paper on "The Study of Phosphorus Uptake in Protozoa by Track Radiography" was concerned with a slightly different approach to microbiological problems, since the special autoradiographic method employed (the recording of individual β-tracks from organisms such as *Paramecium caudatum*) enables one to obtain a measure of individual differences in phosphorus-32 content between one organism and another. Since the total number of tracks per organism should not exceed 50 to avoid confusion in counting, statistical variation necessarily imposes a severe limitation on the accuracy of the method, which can, however, be successfully used at very low concentrations of radioactive phosphorus—as little as 10–20 atoms of phosphorus-32 per organism. Location of the origin of the tracks is possible to a limit of resolution of 5 μ, and the method can be used either on sections or on whole organisms, the latter suspended in congealed droplets of photographic emulsion. In a typical experiment, the distribution of phosphorus-32 among a population of *Paramecium* was found to be skewed,

a few organisms showing counts much higher than the remainder. The nucleus did not show any excessive concentration of phosphorus-32. Most of the phosphorus enters from the food eaten, as shown by a low rate of uptake in the absence of bacterial suspensions, as well as by the high radioactivity of food vacuoles in the early stages of the digestive process.

Dr. J. E. Hotchin reviewed "The Use of Radioactive Phosphorus in Virus Studies", with particular reference to the metabolism of phosphorus compounds in virus-infected cells of different types. In effect, since the virus becomes part of the metabolic system of the host itself, this type of investigation links up with the study of the reproduction and metabolism of the virus particles themselves. Direct use of virus labelled with phosphorus-32 is theoretically practicable in the *B. coli*/T2-phage system; an activity of 10 C./gm. of phosphorus can be attained, equivalent to approximately 2 atoms of phosphorus-32 per virus particle.

The use of phosphorus-32 as a chemical method of detecting virus infection was illustrated by the work of Ward, who showed that the turnover of phosphorus in the allantoic fluid of the hen's egg increases ten to thirty times in virus-infected specimens.

Mr. J. H. Scott, under the title "Some Experiments with Radioisotopes and Algæ", gave a vivid account of the difficulties met with in the apparently simple problem of determining the extent of uptake of radioactive cerium and strontium from a circulating culture system containing the alga *Cladophora crispata*. While apologizing for the absence of results of this work, he nevertheless contributed a timely and useful warning of the difficulties of attempting to estimate radioisotope uptake by measuring the decrease in activity of the circulating liquid.

Describing "The Preparation of Radioactive Penicillin", Dr. E. Lester Smith commented on the problems of obtaining products of high activity by biological syntheses. Such compounds have considerable value in following the fate of antibiotics in an organism or even in the chemical handling and processing of the antibiotic itself. Biosynthetic methods, often extremely wasteful, are relatively efficient in the preparation of penicillin labelled with sulphur-35, where 10 per cent of the sulphur appears in the product. A minimum sulphur content of 0·1 mgm./ml. in the culture medium was required for optimum growth, and this demanded careful technique if the initial amount of sulphur-35 employed was to be kept within reasonable limits. A product having an activity of 0·74 μC./I.U. was obtained.

Drs. P. D. Cooper, V. Few and D. Rowley gave a brief account of "The Uptake of Penicillin by Bacteria". The removal of unbound penicillin from bacteria or from bacterial cell walls by centrifuge washing and by electrodialysis showed that sensitive staphylococci bound 2–3 I.U./gm. dry-weight, while resistant organisms bound much less. This result was ascribed to the presence in the sensitive strains of a 'penicillin-binding compound', the reaction of which with the antibiotic is the initial step in the toxic process. Examination of the staphylococci after mechanical breakdown suggested that the penicillin-binding compound was associated with the cell wall; the amount present per cell appeared to increase when growth occurred in a penicillin medium.

The symposium was clearly designed to direct the attention of practising microbiologists to the possibilities of work with isotopes; such methods have already made a very substantial contribution to the biochemical side of the subject. How far such general meetings are of value now that this newest of analytical weapons has had a decade in which to establish its reputation may perhaps be doubted; the impression given was that most of the audience were already familiar with its potentialities. The extensive references to American work by all contributors prompt a rueful reflexion on the commanding lead which the United States has obtained in this field. Apart from the relatively late start in Great Britain, two reasons suggest themselves. The financial support for biological applications of the method is out of all proportion to the resources which are going into its physical development. Also, successful work with isotopes nearly always requires the participation of a team of workers with adequate technical assistance, and large-scale development of such researches makes heavy demands on man-power as well as money. These problems are not fully recognized in Great Britain, either in our training facilities or in our financial provision for biological research.

NEWS and VIEWS

Egyptology in University College, London: Mr. W. B. Emery

Mr. W. B. Emery, who has recently been appointed professor of Egyptology at University College, London, is the leading and most experienced of the present generation of British excavators in Egypt. He was trained in the University of Liverpool Institute of Archæology under the late Prof. T. E. Peet, and, after a year as assistant secretary of the Institute, during 1923–24 had his first field experience in the excavations of the Egypt Exploration Society at Tell el Amarna. In 1924 he was appointed assistant to the late Sir Robert Mond, and during the next four years worked and excavated on his behalf in the Theban Necropolis. During these years Emery was also responsible for the consolidation and restoration of the Tomb of Ramose, and discovered and conducted the preliminary excavations of the tombs of the sacred Buchis bulls and their mothers at Armant. From 1929 until 1934 he was director of the Egyptian Government's Archæological Survey of Nubia, and found and excavated the barbaric but magnificent tombs of the X-Group kings and their followers at Ballana and Qustol. In 1935 he followed Quibell and Firth as director of the Egyptian Government's excavations at the Archaic Cemetery at Sakkara North. This is one of the most important sites in all Egypt, and Emery's work, unhappily interrupted by the Second World War, at once produced results of the highest importance and significance for the early history and architecture of Egypt. Though the matter is still undecided, it is possible that he has discovered the tombs of some at least of the kings of the First Dynasty. During and after the War, Emery had a distinguished record of service in the Western Desert and Cairo; but hitherto it has been impossible for him to resume his excavations at

Sakkara. Mr. Emery is above all an excavator, with a reputation for careful and painstaking thoroughness and detail, and for his beautiful architectural plans and drawings. He possesses to a special degree the experience and capacity to carry on the great Petrie tradition of excavation and training in field archæology. It is much to be hoped that, when conditions in Egypt permit, the funds will be found to permit him to continue his supremely important work at Sakkara.

The Newcomen Society: Dr. H. W. Dickinson

At the annual general meeting of the Newcomen Society, held at the Institution of Civil Engineers on November 21, when Mr. J. Foster Petree was elected president in succession to Dr. C. H. Desch, the Society conferred the title of 'secretary emeritus' on Dr. Henry Winram Dickinson, for his long and devoted services to the Society. Founded in 1920, the Society has steadily pursued its object of furthering the study of the history of engineering and technology, and has gained a world-wide recognition, by the reading of papers, the publication of *Transactions*, the holding of summer meetings in various centres and in many other ways. International in character, the parent Society has now a membership of four hundred, while the North American affiliated Society has more than twelve thousand members. The formation of this vigorous offshoot was due to visits of Dr. Dickinson to the United States, during one of which he was awarded the honorary degree of Eng.D. by Lehigh University. Though all students of technological history are familiar with the Society's *Transactions*, it is generally admitted that the success of the Society is mainly due to the labours of Dr. Dickinson, whether as secretary, president and editor, or as its representative on occasions at home and abroad. Born at Ulverston, Lancashire, in August 1870, Dr. Dickinson, after attending Manchester Grammar School, was trained as a mechanical engineer. In 1895 he joined the staff of the Science Museum, serving in turn under General Festing, Isaac Last, Sir Francis Ogilvie and Sir Henry Lyons. He retired in 1930, after holding the rank of keeper for many years. He has published books on Fulton, Watt, Boulton and Trevithick and the steam engine, while he has contributed more than a score of papers to the Newcomen Society, covering a very wide range of subjects. Though advancing years now cause him to relax his efforts for the Society, his numerous friends will look forward to his long enjoying the distinction he has so well earned.

British Scientific Instrument Research Association: Mr. W. D. Haigh

Mr. W. D. Haigh, who has been connected with the British Scientific Instrument Research Association almost since its formation in 1918, was the first member of the research staff and, in recent years, the superintendent of the laboratories. On October 31, 1951, he retired from the Association, having reached the age of sixty-five. At a luncheon which preceded the Council meeting of the Association on October 30, Mr. Haigh was the guest, and Sir Ronald Weeks, the chairman, and Mr. A. J. Philpot, the director of research and secretary, paid tributes to Mr. Haigh's unswerving loyalty to the Association and to the excellence of his past work. In the November issue (6, No. 11; 1951) of the *Bulletin* of the Association, mention is made of some of the fields of research in which Mr. Haigh has made important contributions. These include abrasives, radioactive paints, solders, glasses and, together with his brother, photographic graticules.

United States National Science Foundation

The Budget recommended by the President of the United States for the first year of operation of the National Science Foundation was 14 million dollars; but this was reduced by the House Committee on Appropriations in August to 300,000 dollars, the Committee refusing funds for the two major programmes of the Foundation, namely, support of basic research and the fellowship programme for training scientific man-power, on the ground that their early aid in the present emergency was not very tangible. Dr. A. J. Waterman, director of the Foundation, stated at a meeting sponsored by the American Institute of Biological Science at Minneapolis on September 10 that all active planning and recruiting by the Foundation had accordingly been suspended. Dr. Waterman added that the public did not yet appear to understand or appreciate the meaning of basic research and the extent to which scientific progress depends upon the constant flow of new ideas from this source. The Foundation had been given the specific responsibility of developing a national policy and supporting basic research and education in the sciences and was also to serve as a clearing-house for information on scientific man-power and general scientific activity in the United States. Support of basic research and education in the sciences, continued Dr. Waterman, was its primary mission, and both were in some danger of neglect.

It was announced, however, on November 4 that the appropriation for the National Science Foundation has been restored to 3½ million dollars under the Supplementary Appropriations Act of 1952, and according to Dr. Waterman about 1½ million dollars will be allocated for the support of basic research in biology, medicine, mathematics, the physical sciences and engineering; about 1,350,000 dollars for the training of scientific man-power; and the balance for development of a national policy for the promotion of basic research and education in the sciences, for the wider dissemination of scientific information, and for other services including support of the National Scientific Register, now established in the Office of Education. Basic scientific research will usually be supported by means of research grants, and approximately 400 graduate fellowships will be awarded for the academic year 1952–53 in the mathematical, physical, medical, biological and engineering sciences. No awards will be made for study in clinical medicine, although applications will be considered from medical students who wish to prepare for careers in medical research. Selection of Fellows will be made solely on the basis of ability, and will be carried out by the National Research Council.

Overseas Work of the British Council

In the summary published in *Nature* of December 1, p. 947, of the activities of the British Council, reference is made to the possibility of overlapping occurring with the work of other bodies in presenting the British point of view. Mr. Paul Reed, information officer of the Council, has pointed out that, under a Cabinet decision of 1946, the activities of the British Council in foreign countries have been confined to cultural and educational work, the Council being empowered to deal with general subjects when approaching university teachers, students and similar

groups, but restricted to purely cultural matters when in contact with the public. In its Third Report for the Session 1947–48, the Select Committee on Estimates, reviewing the work of the British Council, reported that the agreement appeared to be working well and that very little duplication of work in fact occurred. The Select Committee, indeed, saw no justification for abandoning, in favour of the Central Office of Information, the former system whereby the Council was entirely responsible for publishing its own brochures, and deprecated the decision of the Treasury that the Council should buy most of the books it needed through H.M. Stationery Office and not direct from the publishers. Since the Report of the Select Committee was issued, further arrangements have been made to define the scope of the Council's work not only in foreign countries but also in the self-governing countries of the Commonwealth and in the Colonies, and there are agreements with the Central Office of Information and constant liaison to ensure co-operation. Regular consultation also occurs between the Council and the Overseas Service of the B.B.C., because each organization can obviously be of considerable help to the other.

Foods and Fads

The subject of nutrition suffers greatly from didactic statements made by people who have no conception of the difference between a point of view and an established fact. Dr. Charles Hill, in his Armstrong Memorial Lecture, delivered before the Royal Society of Arts on December 12, did well, therefore, to belabour some of these amateur 'nutritionists' and expose the emptiness of many of their much-publicized theories. The making of nonsensical statements about the value of various foods is not, however, confined to food faddists and other cranks. Domestic science teachers and even some members of Dr. Hill's own august profession are rank offenders, and Dr. Hill may indeed have had the former in mind when he referred to "the practice of skimming through tables of food values and looking for those foods which show the highest percentage content of certain nutrients . . . [and taking no account of] the vital factor—how much of it is taken". Unfortunately, even Dr. Hill himself is not immune. In this lecture, devoted as it is to iconoclasm, some of his own arguments are based on so-called 'evidence' that will not stand up to examination. It is time, for example, that the meat-lovers stopped resuscitating the old unfounded story about the Masai and the Kikuyu. There are also quite a number of statements which no doubt raised a laugh when spoken but which, read in cold print, are now seen to have no bearing on the subject. In fact, Dr. Hill relied far more on oratorical devices than on logical arguments in this lecture—especially in his attack on vegetarianism. His delight in scoring off his opponents frequently made him guilty of just that error of which he was accusing them, namely, the dictatorial assertion of 'facts' for which there is, as yet, no scientific proof one way or the other.

The Bee Research Association

The Bee Research Association, which was incorporated in January 1949, has now issued a handbook (obtainable from Dr. Eva Crane, 55 Newland Park, Hull, Yorks, price 6*d*.) in which all the current and projected activities of the Association are set out. On the research side the Association aims at bridging the gap between the studies carried out in research institutes and their useful application to beekeeping practice. Large-scale co-operative experiments are in progress on the effect of spring stimulation, methods of management of bees, honey density standards and methods of queen introduction. Advice and assistance are given to beekeepers carrying out individual research work on a variety of topics. From January 1 last the Bee Research Association took over the publication of the *Bee World*. This is appearing in a slightly altered format, and it is hoped, as soon as it is financially possible, to increase its size and to add more illustrations. It will continue to include "Apicultural Abstracts", for which the Association has been responsible since January 1950. In order to tide the journal over its present financially difficult period, a "*Bee World* Fund" is being created for which donations and interest-free loans are being sought. Full details can be obtained from the Hon. Subscription Secretary, F. E. D. Hodges, 10 Barnett Wood Lane, Ashtead, Surrey.

Lady Tata Memorial Trust Awards

The Trustees of the Lady Tata Memorial Fund invite applications for grants, scholarships or fellowships for research on diseases of the blood, with special reference to leukæmia, in the academic year beginning on October 1, 1952. Grants of variable amount are made for research expenses or to provide scientific or technical assistants for senior workers. Scholarships are awarded for the personal remuneration of workers carrying out approved research under suitable direction; their normal value will be £600 for whole-time research. In addition, the Trustees may award one or more Lady Tata Memorial research fellowships to workers with considerable research experience; the stipend of these fellowships would be at the rate of £1,000 per annum. The awards are open to investigators of any nationality. Forms of application can be obtained from the Secretary of the Scientific Advisory Committee of the Fund, c/o Medical Research Council, 38 Old Queen Street, Westminster, London, S.W.1. Applications must be submitted before March 31.

Conference on Religion and Evolution

In response to a request by many teachers, a Conference on "Religion and Evolution" will be held at University College, London, during March 7–8, under the auspices of a number of societies concerned with biology in education. The opening address will be given at 7.30 p.m. on March 7 by the Very Rev. W. R. Matthews, Dean of St. Paul's, who will speak on "Evolution and Theology". On March 8, Dr. L. M. J. Kramer, senior biology master in the City of London School, will give a lecture-demonstration entitled "Alpha and Omega", in which he will deal with some practical relations between religious and biological teaching in schools on the origin of man. There will also be talks on "The History of the Idea of Evolution", by Dr. A. C. Crombie, lecturer in the history and philosophy of science at the University of London. Ample time will be allowed for discussion of the interrelations between religion and evolution and particularly of the practical problems encountered by teachers in the classroom. The fee for the whole conference is 7*s*. 6*d*., and for single sessions, 2*s*. 6*d*. Tickets may be obtained from the Secretary, British Social Biology Council, Tavistock House South, Tavistock Square, London, W.C.1.

Colonial Service : Recent Appointments

THE following appointments have recently been made in the Colonial Service : K. Johansen (agricultural assistant, Tanganyika), agricultural officer, Tanganyika ; A. B. Walton (conservator of forests, Federation of Malaya), conservator of forests, North Borneo ; E. C. S. Dawe (director of veterinary services, Bechuanaland), deputy director of veterinary services, Tanganyika ; R. A. Hammond (deputy director of veterinary services, Kenya), director of veterinary services, Kenya ; H. W. C. Newlands and W. G. G. Pevie (senior veterinary officers, Tanganyika), regional assistant directors of veterinary services, Tanganyika ; J. E. R. Roe (senior veterinary officer, Uganda), director of veterinary services, Bechuanaland ; P. J. Sheehy (veterinary officer, Northern Rhodesia), veterinary officer, Bechuanaland ; L. S. H. Walshe (veterinary officer, Sierra Leone), senior veterinary officer, Sierra Leone ; J. P. Parmiter, agricultural officer, Nyasaland ; S. T. Quausah, agricultural officer, Gold Coast ; P. W. J. Edington, assistant conservator of forests, Federation of Malaya ; K. Bloomfield, geologist, Nyasaland ; M. S. Buchanan, geologist, Nigeria ; B. H. Flinter and W. D. Procter, geologists, Federation of Malaya ; P. Joubert, geologist, Kenya ; W. K. L. Thomas, geochemist, Tanganyika ; J. K. Whitingham, geologist, Tanganyika ; P. H. Greenwood, scientific officer, East African Fisheries Research Organization, Jinja, Uganda ; P. N. B. Jackson, scientific officer, Freshwater Fisheries Research Institute, Northern Rhodesia ; J. A. Hammond, veterinary officer, Tanganyika ; T. T. Bestow, engineer geologist, Kenya ; J. W. Bride, assistant conservator of forests, Sierra Leone ; J. W. Bryson, agricultural superintendent, Nigeria ; R. C. Cole, fisheries officer, Federation of Malaya ; T. P. B. Dodd and J. Henderson, assistant conservators of forests, Nyasaland ; M. E. Ford, geologist, Water Development Department, Northern Rhodesia ; T. A. M. Gardner, assistant conservator of forests, Kenya ; J. P. C. Greenway, fisheries officer, Lake Victoria, East Africa High Commission ; B. J. G. Marlow, biologist, Game Tsetse Control, Northern Rhodesia ; M. A. E. Mortimer, fisheries officer, Northern Rhodesia ; E. A. Palmer, assistant chemist, Agricultural Department, Nyasaland ; D. K. Paul, assistant conservator of forests, Fiji ; L. Skilling, assistant conservator of forests, Nigeria ; R. C. Steele and R. McWaters, assistant conservators of forests, Tanganyika.

Announcements

THE following appointments have been made in the University of Sheffield : A. R. Curtis, lecturer in applied mathematics ; K. J. W. Alexander, lecturer in economics.

DR. L. VALENTINE has been appointed lecturer in the chemistry of high polymers in the Department of Textile Industries, University of Leeds, from July 1.

THE following appointments by the University of London have been announced : Mr. N. H. Ashton, to the University readership in pathology, tenable at the Institute of Ophthalmology. The title of reader in the University has been conferred on Dr. Reginald Lovell (veterinary bacteriology), Dr. J. N. Oldham (veterinary parasitology), and Dr. H. F. Rosenberg (veterinary physiology), in respect of the posts held by them at the Royal Veterinary College.

THE Medical Research Council invites applications for a second series of fellowships in clinical research, tenable at centres in the United Kingdom during the academic year 1952–53. These fellowships are open to suitably qualified medical graduates who desire to prepare themselves for a career in clinical research. Stipend will be at the rate of £850 per annum, rising by annual increments of £75 to £1,000 per annum. Applications must be sponsored by the head of the appropriate department in the candidate's university or medical school. Application forms can be obtained from the Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1, to whom they must be returned not later than March 1.

THE National Research Council of Canada is offering some forty postdoctorate fellowships for the year 1952–53. These awards are tax-free and are worth 2,820 dollars a year for single persons and 3,300 dollars a year for married men ; fellows from abroad will get travel grants. About twenty fellowships are to be granted in pure chemistry and fourteen in physics, these two groups being tenable at the Ottawa laboratories of the Council. Five fellowships, tenable at the Council's Prairie Regional Laboratory in Saskatoon, will be awarded in biochemistry, microbiology and related fields. Applications and supporting documents should reach Ottawa before February 15. Further details can be obtained from the Secretary, Laboratories Awards Committee, National Research Council, Ottawa, or from the Chief Liaison Officer, National Research Council of Canada, Africa House, Kingsway, London, W.C.2.

AS in former years, a symposium on molecular structure and spectroscopy will be held in the Department of Physics and Astronomy, Ohio State University, during June 9–13. The programme will include discussions of the interpretation of molecular spectroscopic data, as well as methods of obtaining such data, and sessions on aspects of spectroscopy which are of current interest. Further information can be obtained from Prof. Harald H. Nielsen, Department of Physics and Astronomy, Ohio State University, Columbus 10, Ohio.

THE Institute of Metal Finishing, in conjunction with the American Electroplaters' Society, announces the formation of the International Council for Electrodeposition. The object of the Council is to initiate and co-ordinate all activities of member societies where international action is necessary or desirable. Such activities may include the holding of international functions, questions of nomenclature and terminology and the representation of the interests of electrodeposition on international bodies. Representation on the Council is initially confined to the founder bodies ; membership of the Council is, however, open to any society, one of the main interests of which is the subject of electrodeposition. The headquarters of the International Council are 27 Islington High Street, London, N.1, and the honorary officers are : *Chairman*, Mr. H. Silman (president, Institute of Metal Finishing) ; *Hon. Corresponding Secretary*, Dr. S. Wernick (hon. secretary, Institute of Metal Finishing) ; Dr. W. R. Meyer (American Electroplaters' Society) ; Mr. W. L. Pinner (American Electroplaters' Society).

THE Royal Commission for the Exhibition of 1851 has decided to increase the basic value of its research scholarships for students from the overseas countries of the Commonwealth from £350 to £450 a year, as from July 1, 1952.

PITFALLS IN PARTITION CHROMATOGRAPHY

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IT has been a cardinal feature of chromatography that a pure substance gives a single band. This has, indeed, been proposed as a test in the sense that the appearance of one band only from a supposedly pure substance is presumptive evidence of homogeneity, while separation into two or more bands amounts to virtual proof that the preparation is a mixture. I write with feeling on this matter, because the use of this test led my collaborators and me to make a superfluous addition to the already overburdened nomenclature on vitamins[1-3]. It now appears that "vitamin B_{12d}" is identical with vitamin B_{12b}. Although the present investigation has been largely concerned with elucidating the anomalous results with this vitamin, the work appears to have much wider application. We find that partition chromatography with solvents that, like butanol, dissolve much water, demands more attention to details than is needed with drier solvents, such as ether.

Two or Three Chromatogram Zones from a Single Solute

The chromatographic system that we have studied most is kieselguhr mixed with half its weight of water or dilute buffer solution, suspended in *n*-butanol saturated with water. It has been found that a single substance can give rise to two, and sometimes even three, distinct bands on such chromatograms unless they are run under rigidly controlled conditions. The trouble occurs because the solvent used to prepare and develop the column contains much more water than is held by the kieselguhr. If the solvent is not fully saturated with water, it therefore tends to abstract water from the upper layers of kieselguhr in the column; if, on the other hand, it contains extra water in fine suspension, this will be deposited on the kieselguhr to form an excessively wet surface layer in which the aqueous phase may become locally continuous instead of being dispersed as micro-drops or as a kind of fine web throughout the porous kieselguhr. Kieselguhr appears to hold water in a purely mechanical fashion, so that any deficit of water in the solvent passing through is quickly made up at the expense of the column. Silica, which we used formerly, holds water more strongly and can abstract water even from butanol that is not fully saturated[4,5]; thus silica columns are not very sensitive to the moisture content of the solvent, and indeed are preferably run with butanol only about two-thirds saturated.

Kieselguhr had been selected to overcome the complication due to adsorption of the B_{12} vitamins by silica. After our experience with silica, we did not at first appreciate the need for maintaining precise saturation of the solvent; moreover, this is not so simple to achieve as might be supposed. It requires very vigorous shaking with water to ensure that butanol, which is rather viscous, becomes fully saturated. Further, any slight excess of water is apt to remain suspended in fine dispersion, even for hours, and may not be noticed on cursory examination because a suspension that looks only faintly opalescent may still contain enough undissolved water to upset the column. Again, small changes in laboratory temperature alter the solubility of water in butanol and so cause the kieselguhr column to gain or lose water.

These phenomena affect principally the upper layers of the column, making them unduly wet or dry. Therefore serious abnormalities are only observed with extremely hydrophilic solutes, that is, those having low R values and tending to remain near the top of the column. Thus we only had trouble with vitamin B_{12b}, and none in separating the faster-moving vitamins B_{12} and B_{12a}.

The chromatograms were prepared in 18-mm. diameter tubes with sealed-in sintered glass disks to support the column, which contained about 10 gm. of kieselguhr carrying half its weight of 2 per cent phosphate buffer, usually at *p*H 7. The columns were compacted gently by forcing water-saturated *n*-butanol through them under slight air pressure. The whole apparatus was immersed in a 25° C. thermostat.

After much preliminary investigation, it was eventually found possible to reproduce at will conditions that would yield two or three separate bands from the single substance vitamin B_{12b}. This clearly required some sharp discontinuity in the column or a sudden change in operating conditions. The discontinuity could take either of two different forms: one, a water-logged film, the other a relatively dry section, at the top of the column. The wet film could be created in one of three ways: (*a*) by running through the column butanol (for example, 10 ml.) containing about 0·1–0·2 ml. of excess water in fine suspension, before adding the solute; (*b*) by adding the solute (about 2 mgm.) in a similar mixture of butanol and excess water; (*c*) after adding the solute in saturated butanol and allowing it to soak in, by developing at first with solvent containing excess water. Unless otherwise mentioned, the columns were further developed with saturated butanol under gravity at a flow-rate around 0·5 ml. per minute. It was presumed that the undissolved water was strained out by the top millimetre or less of the column, creating a water-logged film that dissolved part of the solute. The relatively rapid flow of mobile phase would not then have time to attain equilibrium with this 'bulk' aqueous phase, as it would with the normal micro-drops dispersed through the rest of the kieselguhr. Thus a portion of solute would remain 'trapped' in the wet surface layer and would move scarcely at all, while the portion that escaped trapping would form a band moving at the normal rate; the two zones might be linked by a pale region containing the small proportion of solute leached continuously from the wet film. The appearance of the actual columns accorded well with this description deduced from the suggested events.

On several occasions the two bands were separated mechanically from the extruded column and eluted with water. Colorimetric measurements showed that the proportions of material from the two bands were not constant. For both bands the microbiological assay tallied with the colorimetric. Material from each band was brought back into concentrated butanol solution and applied to new columns; each again showed two bands, confirming that the non-uniformity lay in the columns rather than in the solute. However, this could also be demonstrated on the original column, by developing it for a short time with butanol nine-tenths saturated with water, which

dissolved out the excess water from the top of the column, and with it the 'trapped' solute. On continuing the development with saturated solvent both bands settled down to move at the same normal rate, that is, with an R value of 0·04–0·05: on these columns vitamin B_{12} and B_{12a} showed R values of 0·27 and 0·40 respectively. We cannot account for the discrepancies between these and the higher R values we obtained earlier[1], except that formerly we used long narrow columns, which may have been more loosely packed, and a different batch of kieselguhr.

Alternative Mechanism causing Double Zoning

The columns sometimes showed two bands when no excess water was present, and an alternative mechanism had therefore to be found. This second type of discontinuity in the columns occurs when they are unduly dry at the top, instead of wet. Kieselguhr will adsorb vitamin B_{12a} from solutions in butanol that are not fully water-saturated. Under our operating conditions the amount adsorbed was only enough to colour the kieselguhr faintly pink. However, if such a section appeared near the top of a column, and this was afterwards developed with fully saturated butanol, the adsorbed material was readily eluted by the wet solvent; it travelled quickly to form a sharp red line, presumably at the junction of the over-dry section with the normally damp part of the column, and then moved with the normal R value.

This observation gave a clue to the triple bands sometimes observed. They can be produced deliberately by first developing (or preparing) the column with solvent carrying suspended water, developing with saturated solvent until the two bands are well separated, then changing to under-saturated solvent and finally back to fully-saturated solvent. Accidental selection of this sequence of operations may sound improbable; but in practice it can occur, either through the use of several lots of 'saturated' solvent prepared without due care, or from the effect of changes in laboratory temperature on the same batch of solvent during the many hours needed to develop these slow-moving chromatograms.

The effects could, indeed, be induced by deliberately altering the temperature of the column over a range of only 5° C. (20° and 25° C.), using when appropriate solvent that had been saturated with water at the other temperature. For example, a column was prepared at 25° and then cooled to 20°, and 20 ml. of butanol saturated at the former temperature was run through; the haze of water droplets formed on cooling was enough to produce a wet film at the top. After adding the vitamin B_{12a}, development was continued with butanol saturated at 20°, when two red bands gradually separated. Adding the vitamin B_{12a} before the operations at the lower temperature also gave two bands.

Dyes as Solutes

Numerous dyes and indicators were examined in the search for some other solute that would replicate the behaviour of vitamin B_{12a}. All were extracted from aqueous solution by butanol either too readily or not at all, except for a pea-green dye of unknown constitution used for food colouring. It appeared to be homogeneous, giving a single zone on properly controlled chromatograms, moving even more slowly than vitamin B_{12a}. Two green bands appeared, however, on prolonged development, if a wet zone at the top of the column was induced by deliberate addition of a trace of suspended water before, with or after the solute, or on lowering the temperature by 5°. The upper almost stationary green band could be made to travel down the column by development with very slightly undersaturated butanol (98 parts water-saturated, to 2 parts dry butanol). This dye was not adsorbed appreciably by kieselguhr, and thus double zones did not appear on over-dry columns.

Speed of Development

Two other phenomena encountered could interfere with the uniform development of these chromatograms, although they could scarcely explain the splitting of a band into two. It was easily possible to run the mobile phase too fast for equilibrium with the static phase to be maintained. There was then a tendency for solvent passing through the band to take up less solute than it should and to travel too far before redepositing all its solute in adjacent layers. The effect was to broaden the band and to increase the R value. Increasing the flow-rate from 0·5 ml./min. to 2 ml./min. raised the R value only slightly; however, decreasing the flow-rate to about 0·1 ml./min. did lower the R value considerably, though development then took so long that the band broadened by diffusion. Thus it appeared that our standard rate was probably still too fast for equilibrium to be maintained. This effect has been noted with other systems, and indeed in our own earlier work with B_{12} vitamins on starch columns[2]; here is a further reminder that good chromatography sometimes calls for exceptional patience.

pH Gradient on Chromatograms

The other disturbing phenomenon was a pH gradient on buffered columns. In our earlier experiments we used as static phase 2 per cent potassium dihydrogen phosphate to buffer the system at pH 4·5, knowing that the partition coefficient for the basic vitamin B_{12a} was strongly affected by pH. However, phosphoric acid is appreciably extracted from water by butanol, and in partition chromatography the static phase makes contact with successive elements of mobile phase that may total a hundred times its volume. There is a tendency, therefore, for acid to be leached out from the upper layers of the column, leaving them with a higher pH. It should be noted that this disturbance is only lessened, but is not eliminated, by shaking the developing solvent with a little of the buffer solution used for the column. In extracting some phosphoric acid the solvent alters the pH of this buffer, so that to achieve equilibrium it is necessary to shake the solvent with buffer solution in such quantity as to prevent its pH from altering sensibly. Thus a buffered column carrying basic or acidic solutes will behave differently when it is developed with inadequately equilibrated solvent or when, as sometimes, with the first runnings of effluent solvent, which would be in equilibrium with the static phase.

The genuineness of the phenomenon was established in three ways. Portions of 2 per cent potassium dihydrogen phosphate solution were extracted with various proportions of wet n-butanol, and their pH was afterwards measured, with the results shown in the accompanying table.

	pH by glass electrode
2 per cent pot. dihyd. phosphate solution	4·52
Same, just saturated with n-butanol	4·70
Same, after shaking with 1 vol. n-butanol	4·75
" " " " 20 " "	5·47
" " " " 40 " "	5·82

Secondly, buffered columns were run with a suitable indicator (bromcresol green or bromphenol blue) as solute. The colours changed to an extent equivalent to about 1·5 *p*H units on passing down the columns. Moreover, after long development of a *p*H 4·5 buffered column with wet butanol, an aqueous extract of the top section had a *p*H of 7. Thirdly, vitamin B_{12b} exhibited a fall in *R* value during passage through such a column.

The effect of such a *p*H gradient (less acid at the top) is to give a progressively falling *R* value to basic substances and a progressively rising one to acidic substances. Rising *R* values will tend to improve separations, and some particularly effective buffered chromatographic systems may undesignedly exploit this effect. An example is afforded by phthalate-buffered paper strips developed with a mixture of *iso*propyl ether and *iso*propyl alcohol, as used by Baker, Dobson and Martin[6] for chromatography of the hydroxamic acids derived from the various penicillins. Spotting a developed strip with bromcresol green indicator suggested a gradual change from about *p*H 4·8 to *p*H 3·8 from top to bottom of the strip.

Application to Paper Chromatography

The precautions that we have found necessary may well apply to the more popular kind of partition chromatography in which filter paper is used to support the static phase, for in this field the use of potentially trouble-producing solvent mixtures containing a high proportion of water is common. Consden, Gordon and Martin[7], the originators of this technique, record the effect of temperature on the composition of the two phases in the phenol–water and collidine–water systems and the resulting changes in R_F values of various amino-acids. They also mention the need for a completely closed chamber saturated with the vapours of solvent and water to prevent changes in the composition of the developing solvent arising by evaporation. Hanes and Isherwood[8] go further and recommend a thermostatically controlled enclosure and a fanning device to ensure equilibration of the spotted-out paper strip or sheet with the vapour phase before the addition of developing solvent.

Salts present in the solute interfere by attracting water and producing a water-logged spot near the origin. This was also noted by Consden *et al.*[7], and they later[9] designed a device to eliminate salts electrolytically. Partridge[10] found it necessary to desalt sugars before their paper chromatography and achieved this with ion-exchange resins.

These authors have reported distortion and tailing of chromatogram zones, and changes in R_F values, from failure to observe these precautions, but not the appearance of more than one zone from a single solute. In the few instances where the last phenomenon has been observed, it has usually been attributed to chemical rather than physical causes, though the latter may merit consideration in any re-investigations of these anomalies. Thus Hanes and Isherwood[8] attributed 'ghost spots' of phosphate esters, remaining at the origin, to the presence of alkali-earth impurities in the filter paper. Aronoff[11] attributed multiple spots with lysine at different *p*H values to salt formation between the various ionic species and the solvent, phenol. Partridge[10] found double spots with glucuronic acid due to partial lactonization. Bayly, Bourne and Stacey[13] have recently reported two or three spots from glucose and other aldoses chromatographed under certain conditions.

Proteins mixed with hæmin and certain wetting agents and developed in two dimensions with aqueous solutions give patterns of many spots that probably do not correspond with individual proteins[12,14].

Finally, vitamin B_{12b}, the solute that gave trouble on our kieselguhr columns, has occasionally given us two spots on paper-grams; Cooley, Ellis, Petrow, Beaven, Holiday and Johnson[15] have also reported this phenomenon.

Water-logging of the paper is not necessarily a fault in all applications of paper chromatography. Indeed, it has been deliberately exploited in a few instances to assist separations; the paper strip then shows not only the usual 'solvent front' but also a second front nearer the origin representing the extent of travel of the water-rich phase. This state of affairs holds with several methods for the separation of inorganic ions on paper[16] and probably also in Carter's method for the separation of nucleotides by upward development from a trough containing an aqueous buffer solution overlaid with *iso*amyl alcohol[17]. For completeness it may be recalled that double zoning has been observed by Schroeder[18] in adsorption chromatography on columns with several nitrogen-containing aromatic compounds.

Summary

A single solute can give rise to two and sometimes three bands on kieselguhr partition chromatograms run with *n*-butanol. Double zoning can be caused by a water-logged film at the top of the column arising from traces of suspended water in the wet solvent. A fall in temperature can produce this result. Alternatively, double zoning with vitamin B_{12b} as solute can be caused by an over-dry section at the top of the column arising from solvent under-saturated with water, a condition that can result from a rise in temperature. The second band arises because vitamin B_{12b} is adsorbed by kieselguhr from undersaturated butanol and is eluted again by the fully saturated solvent. Triple zoning can arise from the successive operation of both causative factors. Other factors that can cause disturbances in partition chromatography are discussed, as are their applications to paper chromatography.

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TRAINING FOR INDUSTRY AND THE PROFESSIONS

THE 1951 Cantor Lectures on training for industry and the professions have now been published by the Royal Society of Arts (*J. Roy. Soc. Arts*, **99**, No. 4853; 1951). The series of lectures was introduced by Sir Godfrey Ince, permanent secretary to the Ministry of Labour and National Service, who suggested that the major part of the training for industry and the professions that goes on in Great Britain is done by industry and by the professions themselves, government taking a lesser part.

In dealing with the man-power position in Great Britain, Sir Godfrey indicated that the outstanding feature of the man-power situation to-day is the scarcity of labour, particularly the scarcity of skilled personnel and of young persons.

The shortage of skilled personnel is matched by the shortage of men of science and technicians of professional and semi-professional standards. As rearmament proceeds and the Colombo Plan, which will require many professionally qualified technicians, develops, these shortages will become more acute.

At the same time there are fewer boys and girls available to enter industry and the professions than before the War. Of boys and girls reaching the age of fifteen, there has been a drop in their numbers compared with the situation before the War from 740,000 to 635,000; of boys and girls reaching the age of eighteen there has been a fall from roughly 840,000 to 640,000. This situation will not begin to improve until 1957 for boys and girls reaching the age of fifteen, nor until 1960 for those reaching the age of eighteen.

In considering the training of young persons, Sir Godfrey declared that all young people should receive an adequate measure of general education, should be given the best possible advice before choosing a career and should be placed in the job which suits him or her best and should be properly and adequately trained for that job.

At present some seventy sections of industry have produced systematic schemes of recruitment and training and have set up machinery which includes a national joint committee or council and local joint committees or panels. The schemes which have been adopted generally cover such matters as methods of recruitment and initiation into industry; ages of recruitment, periods of apprenticeship, and methods of engagement; qualifications for particular occupations; methods of training, including the preparation of model training schemes providing for progressive training, covering, if need be, arrangements for transfer from employment to employment in the same establishment, or between establishments, to ensure the acquisition of all-round skill by the young workers; supervision during training, both within the firm and by a representative body of the industry; and further education and technical training.

Many apprenticeship arrangements have recently been improved, but in some industries the period of apprenticeship is still too long and could be reduced. Experience in the Ministry of Labour in its vocational training centres has shown that by intensive training methods a very high degree of skill can be acquired in a comparatively short time.

Sir Godfrey also said that industry has no systematic schemes of training for adults, although many firms have their own schemes of training both for the purpose of making employees more efficient in their existing jobs and for fitting them for higher jobs. These arrangements are often on an individual basis and are run in co-operation with educational institutions and, to a lesser extent, with voluntary organizations.

In the professions effective and efficient systems of training have existed for a long time. In Sir Godfrey's view, the professions are fully alive to the need for modifying their arrangements to meet the changed circumstances of the times and of maintaining their high and established standards. Like industry, commerce and the Armed Forces, the professions will all feel the effect of the acute shortage of young persons during the next ten years. The professions, however, are likely to suffer least because of the increasing numbers that are receiving secondary and higher education.

One general problem affects a number of professions—the gap between the school-leaving age and the age of entry into the professions. This question of 'bridging the gap', as it is called, is well known, for example, to the nursing profession. It is essentially a training problem—a problem of pre-entry training. Unless sound schemes of 'earning and learning' during the period between leaving school and being able to start training are introduced by those professions that are affected in this way, they will have increasing difficulty in securing the necessary recruits to train.

Sir Godfrey then reviewed the training given by educational institutions. Education in the schools is not of itself sufficient, and the necessary qualifications have to be obtained by continuing education at technical colleges or universities, or they may be obtained within the professions or industries themselves.

Boys and girls who enter employment immediately on leaving school are often able to continue their education and receive training either on a part-time basis during the day-time, or at evening classes. It is here that technical colleges are so important. In general, technical colleges provide both full-time and part-time education, and the field they cover extends from theoretical education appropriate to apprentices—aiming at becoming skilled craftsmen and perhaps to go no further—to the highest qualified professional, technical and scientific personnel.

Some of the technical colleges have been training men and women for industry and commerce for the past hundred years, and the valuable contribution which they have made to our national industries has not been sufficiently recognized. The past successes of the technical colleges and their beneficial effect on industry have been mainly dependent on the initiative, enterprise, and progressive outlook of the individual students whose tenacity carried them through many years of evening attendance. In 1949, of a total of 2,115,000 students at technical colleges, 50,000 were full-time, 265,000 part-time, and no less than 1,800,000 were evening students.

In recent years there has been a much greater appreciation by industry and commerce of the value of technical education. In 1949, for example, about 85 per cent of the part-time students were released by their employers during working hours. While much credit is due to industry for the more enlightened view taken recently, the extent of part-time release is still relatively small and much remains to be done.

The link between education and industry, commerce, and the professions in the field covered by

technical colleges is of vital importance; wherever industries are to be developed, technical education at all grades is essential. In the apprenticeship field it is most important that the syllabus of instruction in technical training should be closely related to the practical training the apprentice is receiving in his work. The same is true in the higher ranges. As an example of the close collaboration which to-day exists between industry and education, and which should be developed whenever possible, it is worth noting that much of the part-time education is carried on by teachers normally employed in industry.

After considering the role in training of government as employer, Sir Godfrey considered the part played in training by government as government.

The main role of government is that of supplementing the efforts of industry and the professions themselves. Government, as government, only trains directly where there is a special and pressing need in the national interest and where the government has a special obligation. Apart from this, government's activities are confined to seeing that the necessary facilities for training are available to industry and the professions, and, where necessary, to assisting in the provision of those facilities.

Direct training given by government, as government, has always been limited to adults. The need for government to train adults for skilled crafts first arose in an acute form towards the end of the First World War, when large numbers of ex-service men could not return to their pre-war jobs because of their disabilities. Afterwards, when these schemes for resettling disabled ex-service men came to an end, vocational training was given to younger unemployed men in areas of heavy unemployment to equip them for fresh employment. In addition, training courses were given to those needing them as a result of prolonged unemployment in order to rehabilitate them—to make them physically fit to take a job. All this training took place in government training centres.

With the possibility of war a change in the nature of the training took place in 1938, and, from this date, the main object of the sixteen training centres was to train men and women for the engineering and allied industries.

After the outbreak of war in 1939, there was a wide extension of training in the government training centres. During the war years, 270,000 men and 150,000 women were given training courses of one kind or another. The great majority were for the munition industries; but 48,000 were for coal-mining and 56,000 were service tradesmen for the Armed Forces. The bulk of the training was of a semi-skilled nature; but much of it was of a highly skilled nature and many skilled tradesmen were given higher-grade training.

At the end of the War another change took place in the training scheme, which was redesigned to achieve two objects: first, to provide a resettlement scheme giving training in a large number of crafts to men and women whose careers had been disrupted by war service, whether that war service was with the Armed Forces or on civilian war work; secondly, to train men and women to meet shortages of labour in trades of national importance. Such shortages were at first most marked in the building industry, and in the immediate post-war years the principal emphasis was placed on training for the main building crafts. Towards the end of 1947, as a result of cuts in capital investment, training in the building trades was curtailed and limited to disabled persons, although there still continues to be a shortage in some of the crafts in many areas. At the same time, facilities were expanded for training in a number of other trades of national importance.

The new rearmament programme may cause a further change, and it would appear that government training centres will again be required to train men and women as semi-skilled operatives for those industries that will have to expand, and also to undertake some higher-grade training to increase the supply of very highly skilled men.

Government has also recognized through the Disabled Persons (Employment) Act that it has a special obligation for all disabled persons, whether disabled by war service, by accident or from birth. This Act empowered the Minister of Labour to set up training courses for those disabled men and women who need to acquire new skills to be resettled in suitable employment; it also empowered the Minister to set up Rehabilitation Units to assist disabled persons to re-establish their self-confidence and regain their working capacity.

Training courses are in operation at government training centres, at technical colleges and in employers' establishments where disabled persons over the age of sixteen are given intensive courses, in a range of some 140 skilled crafts, while individual training is arranged for other skilled work. In special cases training for semi-skilled employment is also arranged, provided it offers a good prospective of permanent resettlement to the individual disabled person.

For severely disabled persons training is given in residential colleges run by voluntary organizations and aided by government grants. Special arrangements for the training of blind persons are made in collaboration with the various interests concerned with the welfare of blind persons. The government has also set up a corporation—Remploy, Ltd.—to employ the more severely disabled in special factories.

Another scheme of a special nature, aided by government grants, was designed to assist the resettlement in civil life of men and women whose education and training had been checked by war service in the Forces or by work of national importance. This was known as the Further Education and Training Scheme and, under it, about 150,000 men and women have been helped to complete their university education or to resume and complete their professional training.

Yet another special training scheme was the business training scheme for ex-service men. This scheme was designed to make good the gap caused by the War in the intake of executives and managers into industry and commerce. The training was in two parts: first, a three-month course of theoretical study at a technical college, devised with the general idea of telling the trainees what business was about and giving them some conception of the problems and opportunities before them; the second part of the course consisted of practical training with a firm, lasting from six months to two years according to the nature and size of the business. Provision was also made for such part-time study as the firm considered necessary during the period of practical training. The scheme, which was highly selective, proved very successful and gave great satisfaction both to the firms who co-operated and to the young men and women themselves. Altogether, training was given to about 6,500 persons, the great majority

of whom were given immediate employment at managerial, administrative or executive level.

Sir Godfrey also referred to the Ministry of Labour Training within Industry Scheme. The purpose of the Scheme is to train supervisors—and this includes anyone in an organization who directs the work of others, and thus covers all levels of management. The Scheme is concerned with the development of three skills—skills of instructing, of leadership and of improvement of methods. These skills, each of the greatest importance in effective supervision, are common to all supervisors at all levels, irrespective of the industry, business or service in which they happen to be employed.

During the past six years the Ministry of Labour has trained about 2,200 trainers for various types of establishment in one or more of its three programmes, and some 2,700 establishments have adopted Training within Industry in some form.

The second lecture in the Cantor series was given by Dr. A. G. Beverstock, education officer to the Southern Electricity Board, who described in detail the training arrangements being developed in his organization.

He was followed by Mr. F. H. Perkins, education officer to Imperial Chemical Industries, Ltd., who made a similar statement about his undertaking. Mr. Perkins also elaborated four principles on which training should be based. Formal training, he suggests, is only a means to an end and must be very closely linked in form and duration to a particular need. The justification for its existence and its continued use must rest firmly on the assessment of results. It costs money, it absorbs skilled manpower, and it must be assessed in the same way as any other business operation may have to be assessed, although it must be recognized that the evaluation is often an extremely difficult problem. Secondly, although promotion prospects may often be linked with the objects of a training course, training schemes should help to increase interest and improve performance in the present occupations. There should be no passports to promotion attached to any training schemes; men must normally be promoted on the basis of performance on the job and not on ability as students in a training course. The development of greater ability at the present job should in itself enhance the prospects of promotion. Thirdly, training should be primarily concerned in helping those who are prepared to help themselves, and this applies at all levels, from the youngest upwards. The continuation of company assistance in any educational and training activities inside or outside the works or offices must be linked with a keenness on the part of the individual to pursue those opportunities and the ability he displays in profiting by them. Fourthly, a company's training activities must uphold the principle of equality of opportunity. Schemes that give outstanding advantage to some and not to others may lead to discontent and a sense of injustice. The objective must be to help in opening the door to all those who possess the necessary potential but who might otherwise not get the chance.

Under the general heading of training for the professions, Sir Harold Howitt considered the training of accountants, and declared himself firmly against any system of part-time release whereby student accountants could attend educational classes.

The last lecture in the series was given by Mr. Thomas E. Scott, who discussed the training of architects. There are two main methods of training for the architectural profession: pupilage or office training with part-time instruction at day or evening schools, and full-time training in a recognized school. Those who adopt the former course are examined at intermediate and final stages by the Royal Institute of British Architects, while those who adopt the latter are examined in their own schools, degrees and diplomas being awarded on the joint recommendation of internal and external examiners.

T. H. HAWKINS

ABRASION AND WEAR

SYMPOSIUM AT DELFT

THE Rubber-Stichting at Delft celebrated the opening of its new administrative and laboratory buildings by convening an international symposium on "Abrasion and Wear", which was held in the new and well-appointed lecture theatre of this institution during November 14–15. The attendance at the meeting had been limited to about a hundred and fifty participants, fifty-three of whom came from countries outside the Netherlands. The twenty-six British visitors formed the largest single foreign contingent. Altogether, eleven nations were represented at the symposium, which could thus fairly claim to be international. The proceedings of the symposium, which was conducted exclusively in English, consisted of eight lectures of forty minutes each, followed by twenty minutes of discussion. They are being published in *Engineering* and will later be available in book form.

The Rubber-Stichting, like its sister organizations, the British Rubber Producers' Research Association in Welwyn Garden City and the Institut Français du Caoutchouc in Paris, is primarily engaged in the study of natural rubber and in promoting its use. The symposium, however, covered a much wider field of materials and ranged from the mode of action of extreme-pressure lubricants to the wear of cotton shirts. A similar variety of interests was represented by the exhibition of abrasion testing apparatus which had been arranged in the exhibition hall of the Rubber-Stichting. Both general-purpose abrasion machines and special instruments were shown, as, for example, an abrader intended for the testing of wood for clogs under realistic conditions. The largest exhibit was a machine to test model tyres on a rotating abrasion track of concrete. This is a venture of the Rubber-Stichting and is still in the experimental stage. During one of the lunch intervals, an informal discussion took place to give all those who were interested in the testing aspect of abrasion an opportunity of exchanging views on the usefulness or otherwise of the various machines and techniques.

The symposium was opened by Dr. R. Houwink, director-general of the Rubber-Stichting. In welcoming the participants, he stressed that the aim of the organizers of the meeting had been to bring together workers in hitherto unrelated fields of abrasion and wear, so that they could hear about each other's work and benefit from each other's experience. Dr. H. C. J. de Decker, director of research of the Rubber-Stichting, then took over as chairman and presided over the meeting with commendable firm-

ness so that the time-table of the symposium was adhered to.

The first three papers were of a general nature and surveyed the problems of abrasion and wear from different points of view. The first speaker was Dr. F. P. Bowden (University of Cambridge), who in his paper on "The Friction and Surface Damage of Non-Metallic Solids" reviewed the present state of knowledge concerning dry friction and the concomitant surface damage. The similarity between the mechanisms of metallic and non-metallic friction, with the exception of such special cases as that of diamond, was demonstrated, and the influence of chemical constitution on friction was strikingly illustrated by samples of poly-tetrafluorethylene. Prof. H. Blok (Delft), under the title "War on Wear", stressed the economic aspect of wear in its most general sense (including, for example, soil erosion); he outlined briefly the prevalent methods of the prevention of wear, and advocated a concerted attack on the problems connected therewith. Prof. J. J. Broeze (Delft) discussed "Chemical Causes of Wear" under the following three headings: atmospheric pollution; chemical attack by the lubricant which may have become converted into an organic acid; and, in internal combustion machines, incomplete combustion of the fuel. Methods of combating these sources of wear were indicated.

The remaining five lectures were concerned with specific cases of abrasion. Dr. G. Salomon (Delft), in a talk on "Morphological Aspects of Abrasion and Wear", dealt with a microscopic study of the failure of natural and synthetic fibres, their relation to the wear of the corresponding textiles, and the physical and chemical causes of this type of damage. Dr. N. A. Brunt (Delft), talking on "The Abrasion Resistance of Paints", discussed mainly the abrasion of paints under the impact of small particles. According to theoretical considerations, a low modulus is requisite for a low rate of abrasion by impact, a prediction which was borne out by laboratory experiments.

The last three papers all dealt with the abrasion of rubber. Dr. A. Schallamach (Welwyn Garden City), in a paper entitled "Elementary Aspects of Rubber Abrasion", described experiments in which rubber was scratched with a needle in order to imitate the elementary abrasion process, and discussed also the significance of the abrasion pattern found on abraded rubber surfaces. J. M. Buist (Imperial Chemical Industries, Ltd., Manchester) proposed in his paper on "Abrasion and Wear of Rubber" a power law relating the rate of abrasion to the duration of the experiment in question, and explained the practical implications of this empirical equation. The last contribution, "Some Factors influencing the Road Wear of Tyres", came from Dr. R. D. Stiehler (National Bureau of Standards, Washington), who described comprehensive road-wear tests of tyres made both of natural and synthetic rubber, and the statistical evaluation of the results which made it possible to differentiate between the effects of the variables involved in the wear of tyres.

The symposium was wound up by Dr. de Decker, who, in a general survey of the proceedings, listed the various lines of attack on the subject of abrasion and wear, and then proceeded to assess in a well-balanced summary how far the speakers in the symposium had contributed to the body of existing knowledge. It was the general consensus of opinion among the participants of the meeting that, judged by all standards, the symposium had been a success and that it had achieved what it had set out to do, that is, to lead to new contacts and lively exchanges of experiences. Dr. Houwink, Dr. de Decker and all those who helped them are to be congratulated on an exemplary feat of organization. Finally, it should be mentioned that many of the visitors will have taken back with them happy memories of traditional Dutch hospitality.

For those who stayed in the Netherlands for the rest of the week, excursions were arranged to industrial and scientific laboratories.

A. Schallamach

ROTHAMSTED EXPERIMENTAL STATION

REPORT FOR 1950

The report for 1950 of the Rothamsted Experimental Station* records another busy year of successful activities. Visitors to the Station during the year were numbered in thousands and came, individually or in organized parties, from some thirty different countries. It is gratifying to read, alongside this, that the members of the Rothamsted staff were able to visit other centres at home and abroad, for this coming and going must play a great part in maintaining the virility of the numerous and diverse research activities of the Station and in enabling the research workers to keep contact with up-to-date work and opinions elsewhere, and with the problems calling for investigation.

The classical beginnings of the work of Rothamsted centre around the use of fertilizers and the knowledge of their use that was brought to farmers a century ago. It is good to know that while field-work with fertilizers is often tedious and unspectacular compared with a good deal of present-day research, this work continues in relation to modern needs. An example arises from the fact that the quick-acting nitrogenous fertilizers often incur much loss by drainage, while, at the other extreme, certain waste products are too slow to be useful, and the search for something between these extremes is giving encouraging results. Formalized casein—a plastic waste product—has proved useful in experimental work, and there are other possibilities.

Silicophosphate has been compared with superphosphate (the use of which may be limited by restrictions on supplies of sulphur) and was found to compare favourably for use on swedes and re-seeded grassland. Experiments on the placing of fertilizers confirm that its practice enhances yield in the case of shallow-rooted and quick-growing crops, but shows little effect with deep-rooted crops.

Work on the transpiration of water by crops, and on the calculation of the amount of artificial watering as the excess of that vaporized over rainfall, is progressing well and is attracting a good deal of attention overseas. The use of irrigation water in the calculated amount has given some good results, although others, particularly some in which the same amount of irrigation water has given different yields, are the subject of further investigation. The amount

* Rothamsted Experimental Station: Report for 1950. Pp. 184. (Harpenden: Rothamsted Experimental Station, 1951.) 7s. 6d.

of water transpired by crops and the diffusion of water through the stomata are the subjects of important theoretical study. A satisfactory agreement has been found between the estimated rainfall, the estimated evaporation and the run-off from the relevant catchment area.

A study of the uptake of water during germination shows that this occurs in two stages in each of which the water content plotted against time gives an exponential curve. In the first phase, however, dead and living seeds behave alike, and the absorption of water is purely physical. The second phase is definitely associated with the living activity of the growing embryo.

The study of the intake of ions by excised roots may well lead to some better knowledge of the nutrition of plants in solutions and in soils. Consistently with the results of work elsewhere, it has been found that the soluble-carbohydrate content of roots affects, if it does not determine, the rate of uptake of potassium, phosphorus and nitrogen. These investigations, with an examination of the effects of concentration of the nutrients on the rates of uptake, are being continued.

Soil microbiology is still a very active sphere of work at Rothamsted. Research is in progress on nitrification and the relation of *Nitrosomonas* to glucose and to small amounts of metals, and there is considerable work on soil amœbæ, nodule bacteria and root secretions. Actinomyces have been found in the laboratory to give antibiotic secretions which inhibit the growth of certain fungi, and the possibilities of this in the soil are now being investigated.

In the study of clay minerals, considerable attention has been given to the technique of X-ray photography, particularly with the view of reducing the exposure time. It is now possible to obtain a photograph in ten minutes. The geological break between the Upper and Lower Devonian rocks is found to be reflected in clay mineral content—chloritic material characteristic of the Lower Devonian is absent in the Upper. This type of study is being pursued. Complexes of clays of the montmorillonite type with proteins and with pyridine are being examined and should give interesting results. Studies of the reduction of iron under waterlogged conditions as in the formation of 'gley' show that gleying is produced artificially by anaerobically fermenting grass, but this is not necessarily a microbial action since sterile fermented grass extract under anaerobic conditions produces a gleying effect.

Inoculation experiments have been continued in studying the range of hosts vulnerable to the stem eelworm and similar parasites, and some progress is reported in the search for a spring oat resistant to attack. It has been confirmed that the eelworm that attacks oats also attacks rye and vetches. It is impossible to survey all the work on nematodes and the technique of nematology, but one other piece of work that might be mentioned is the study of the movements of potato eelworm larvæ. Movements seem to be limited to a few inches, and the larvæ move upwards more easily than downwards. It has been shown that sufficient concentrations of D.D. mixture and of ethylene dibromide decrease the multiplication of eelworms caused by growing potatoes, but the multiplication was increased by very small dosages. Conditions affecting the eelworm population and potato tubers are being studied by the infestation of a heavy soil modified by sand, by peat, by compost and by artificials. A 20 per cent increase in cysts in the first season affected the tubers where sand and peat were added, but not in the other pots, where compost and artificials increased the potato yield.

The nature, action and isolation of viruses occupy considerable attention at Rothamsted. An examination of the nucleoproteins specific to infected plants shows that only some of this is infective. In the isolation of viruses it seems that in some cases infectivity develops after the virus has been set free from the cell, and some preparations from sap increase in infectivity on standing. The movements and the feeding of aphides that transmit virus diseases are being studied, and the use of radioactive phosphorus in the nutrition of the beet and other plants used may prove helpful in some cases. Some experiments in recent years on the roguing of potatoes suggest that the amount of reduction in disease may not make roguing economical. A large amount of mycological work is going on, and in the course of the study of eyespot it was found, apparently for the first time, that the organism causing this in wheat may also cause a disease in oats.

Only a few of the activities at Rothamsted and its associated institutions have been mentioned in the foregoing paragraphs, but they will serve to exemplify the work recorded in the 1950 report. The report has two important special articles—one surveying fertilizer practice and the other reviewing work on potato root eelworm. There is also a list of 138 publications issued since the last annual report.

CHEMICAL RESEARCH LABORATORY, TEDDINGTON

REPORT FOR 1950

THE report* of the Chemistry Research Board for 1950, which is accompanied by that of the Director of the Chemical Research Laboratory, records that the construction of a specially designed new building for radiochemical research has been commenced, and completion of this is expected to alleviate some of the difficulties from lack of space experienced in the Laboratory generally. The Radiochemical Group has made substantial progress in its work for the Division of Atomic Energy, Ministry of Supply, on the analysis and concentration of uranium in minerals and ores. Further research has been carried out on analytical methods, and a gravimetric method for the final determination of uranium in solutions purified by extraction methods in which cellulose pulp was added to the concentrated liquid before calcination at 800–900° gave rapid and satisfactory results. The separation of tantalum and niobium, and of zirconium and hafnium has been investigated, while the methods described in the recently issued "Handbook of Chemical Methods for the Determination of Uranium in Minerals and Ores" are based on experience with methods, including new chromatographic techniques, developed in the Laboratory. Besides further work on polarographic methods, in which the value of salicylic acid in giving polaro-

* Department of Scientific and Industrial Research. Report of the Chemistry Research Board with the Report of the Director of the Chemical Research Laboratory for the Year 1950. Pp. vi+104. (London: H.M. Stationery Office, 1951.) 3s. 6d. net.

graphic waves for some metals at convenient intervals has been established, the Group, in its Concentration Section, has also investigated methods for the extraction and recovery of uranium from minerals and ores and the mechanism of the reactions occurring in these processes.

The Microbiological Section of the Corrosion Group was established as an independent section in January 1950, and has since then been responsible for the maintenance of the National Collection of Industrial Bacteria. The emphasis in its work has been shifted from anaerobic microbiological corrosion to fundamental studies of sulphate-reducing and sulphide-oxidizing bacteria and their application, particularly in the disposal of refuse in wet pits and in the production of sulphur. Experiments carried out in collaboration with a local authority indicate that it should be possible to devise a method for tipping refuse into pits filled with water in such a way that sulphate reducers have no opportunity of developing on a scale sufficient to cause a nuisance. In May 1950 two officers of the Section made a thorough examination of the sulphur-producing Lake Ain-ez-Zauia in Cyrenaica and a cursory examination of three other lakes of this type. Although isolation of pure cultures of the sulphate-reducing bacteria from the samples obtained proved unexpectedly difficult, the Board is of the opinion that these investigations should be pushed ahead vigorously.

In the Corrosion Group the study of surface films has been extended by a new fundamental investigation for correlating the results of studies of oxidation of evaporated metal films at low temperatures with those of similar experiments on massive metal surfaces. The investigation of low-temperature oxidation of mild steel has continued, and the film-stripping technique has been applied to the examination of 'ferrous oxide layers' on iron. Further attention has been given to the improvement of both the high-speed and low-speed rotor techniques in studies of the corrosion of steel in moving conditions of immersion, while electrochemical studies of painted steel have thrown further light on the mechanism of the breakdown of paint in sea-water. Satisfactory reports continued to be received regarding the effectiveness in conventional cooling systems of vehicles of the 'mixed inhibitor' of sodium benzoate and sodium nitrite, but further investigations are required in systems with aluminium in juxtaposition with other metals. The mixed inhibitor has also been applied in wrapping materials, and an intensive study is now being made of the sodium salts of substituted aromatic acids as corrosion inhibitors. Further work has been carried out on the Becker-type accelerated atmospheric-corrosion test apparatus, and on the mechanism of atmospheric corrosion; excellent results have been obtained with compounds prepared from nitrogenous bases and carbon dioxide, such as *cyclo*hexylamine 'bicarbonate', as vapour-phase inhibitors of corrosion, while work on the extensive bibliography of corrosion has been intensified.

Much of the work of the Inorganic Group on the minor metals has again been devoted to gallium; and its purification, particularly the elimination of alkali metals, has been thoroughly studied as a counterpart to the examination of its physical properties by the National Physical Laboratory. Greater attention is now being given to the preparation of pure germanium, particularly with regard to the use of this element as a semi-conductor. Exploratory work on the replacement of sulphuric acid wholly or partly by nitric acid in the production of phosphate fertilizers is now virtually complete, and an investigation is proceeding on the conversion of rock phosphate to forms assimilable by plants by fusing with serpentine at about 1,400–1,600°. Rapid quenching is required to give satisfactory solubility in citric acid. Increasing demands on both the spectrographic and microchemical analytical services have limited work on the improvement of existing methods and development of new methods.

The work of the Organic Group has continued on similar lines to those of the previous year: neither staff nor space were available to implement fully a scheme for the preparation of chemicals, not otherwise obtainable, for use by research workers in universities. The Purification and Measurements Section is preparing a number of substances, including hydrocarbons and pyridine and its homologues, in extremely high purity for the measurement of thermodynamic constants in the National Physical Laboratory, and some 250 samples of hydrocarbons were distributed as mass spectrometric standards. The Organic Intermediates Section also prepared some isotopically labelled compounds, including urea containing carbon-14 and a salicylic acid derivative, at the request of the Medical Research Council; but there is no present prospect of a comprehensive service of special chemicals for all would-be users. Work on the vapour and solution absorption spectra of pyridine, α-, β-, and γ-picoline, and 2 : 6-lutidine has been completed, and in collaboration with the National Physical Laboratory water triple-point cells were constructed for daily use in checking the ice-point of the platinum resistance thermometer. An attempt to explore the effect of variation in chain structure in N-substituted piperidines on insecticidal properties showed that the dipiperidino-methane and mono- and di-piperidino-methylphenols obtained by the Mannich reaction from piperidine, phenol and formaldehyde had very low activity, while a series of N-Δ$^{\omega}$-alkenylpiperidines was almost inactive. An attempt was made to obtain systemically-active esters by combining the N-alkylpiperidine and the *bis*-(dimethylamino)phosphonous acid groups, but the 3-piperidinopropyl ester is only slightly active and the quaternary and other derivatives are inactive. Other work was concerned with the hydrogenation of α-picoline to α-pipecoline, the preparation of anion-exchange resins containing quaternary nitrogen atoms and the construction of a fractionating column of the spinning bond type for use in the purification of long-chain fatty-acid esters.

The main effort of the High Polymers and Plastics Section has been devoted to studies of the ion-exchange and allied properties of high polymers. The preparation of a series of sulphonated polystyrenes of different degrees of cross-linking has been completed, and the marked dependence of the relative affinity-coefficients on both the composition of the resin and on the degree of cross-linking of the resin has been established. The general study of the kinetics of exchange on sulphonated cross-linked polystyrene has been continued, and it has been shown that the rates of exchange of cations with such polystyrenes depend on the degree of cross-linking of the resin structure. The extreme simplicity of the 'mixed-bed de-ionization' process for the preparation of water of very low specific conductivity has been confirmed. Osmometric methods for determining the molecular weights of polymers in solution are being examined.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Analysis of Counter-Current Distribution Curves

THE increasing use of counter-current distribution between solvents, in machines of the kind developed by Craig[1], for the purification of natural products prompts us to direct attention to simple relationships which exist between successive fractions withdrawn from such machines but which do not appear to be generally appreciated.

After the 'fundamental procedure'[2] under ideal conditions, the fractions of a single substance in successive tubes of the machine are given by the terms of a binomial expansion[3-6]. If K is the partition coefficient $\left[=\frac{C,\text{ upper phase}}{C,\text{ lower phase}}\right]$ of a substance distributed in a machine having a series of tubes numbered from 0 to R, and if the upper phase is mobile, the fraction of the total material $T_{n,r}$ in tube r after n transfers is given by:

$$T_{n,r} = \frac{n!}{r!\,(n-r)!}\left[\frac{1}{K+1}\right]^n K^r, \qquad (1)$$

whence

$$T_r/T_{r-1} = FK, \qquad (2)$$

where $F = (n+1-r)/r$. When the mobile solvent has reached the last tube of the machine, $n = R$.

After the procedure called 'single withdrawal'[2], the distribution of a single substance in the withdrawn series has been described by the following continuous function[2]:

$$y = \frac{1}{\sqrt{2\pi n/K}}\exp\frac{x^2}{2n/k}, \qquad (3)$$

where y is the fraction in a sample that is a distance x from the maximum and n the number of transfers at the maximum. This equation is convenient to use, but it is an approximation which becomes nearly exact only when n is large. Moreover, a value for K must be deduced, by a formula which is itself only approximate, from the position of the maximum, and the latter does not necessarily correspond to the purest material when resolution is incomplete. An exact relationship between successive fractions, however, may easily be derived[7]. If withdrawal of the upper phase takes place from tube R, and if T'_n is the fraction of the total material in the sample withdrawn during the n^{th} transfer, then T'_n is equal to fraction in tube R after $(n-1)$ transfers multiplied by $K/(K+1)$.

Whence from equation (1)

$$T'_n/T'_{n-1} = F_w/(K+1), \qquad (4)$$

where

$$F_w = n - 1/(n-R-1).$$

Similarly, if withdrawal of the lower phase begins from tube 0, the fraction withdrawn during the n^{th} transfer is T''_n, which is equal to [fraction in tube $(n-R-1)$ after n transfers] − [fraction in tube $(n-R-2)$ after $n-1$ transfers] $\times\, K/(K+1)$;

whence

$$T''_n/T''_{n-1} = F_wK/(K+1), \qquad (5)$$

where

$$F_w = n - 1/(n-R-1).$$

Equation (5) also follows directly from (4) if the lower phase is imagined as mobile, so that K is replaced by $1/K$.

Equations (4) and (5) enable values of K to be calculated over any portion of the curve derived from the fractions withdrawn, and the constancy of these values provides a criterion of the purity of the material in the samples concerned. For example, application of the equations to a curve given for fractions of crystalline neamine withdrawn from a 41-tube machine[8] indicates that, if the distributions were carried out under ideal conditions, the material concerned was not homogeneous. The experimental curve can be fitted closely to a theoretical curve calculated for a mixture containing 62 per cent of a substance with $K = 1{\cdot}79$, 35 per cent of a substance with $K = 1{\cdot}18$ and possibly 3–4 per cent of a substance with $K > 2$.

In the course of an extensive investigation of the theory of systematic extraction, Stene[4] showed that the fractions obtained in a process equivalent to 'single withdrawal' formed a Pascal distribution. Equations (4) and (5) are also readily derived from successive terms of this distribution. More recently, Karlson and Hecker[9] have treated the problem in a similar fashion and obtained essentially the same solution. They have also solved the more difficult problem of the relation between successive fractions in the procedure known as 'alternate withdrawal'[2].

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Aug. 3.

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Relationship of Electron Distribution in Amines to Ammine Stability

H. C. Longuet-Higgins and C. A. Coulson[1] calculated the π-electron distribution in certain heterocyclic molecules by the method of molecular orbitals. It was thought that it would be of considerable interest to measure the formation constants of the silver complexes formed with some of these amines. The relative formation constants of the complex silver ions formed by acridine, quinoline, *iso*quinoline and pyridine were measured at 25° C. in 59 weight per cent ethanol–water solution. The formation constants express the equilibrium:

$$Ag^+ + 2\ \text{Amine} = (\text{Ag Amine}_2)^+$$

$$K_f = \frac{(\text{Ag Amine}_2)^+}{(Ag^+)\ (\text{Amine})^2},$$

where (Ag^+), etc., represent the activities of the species.

In nearly all such measurements, either the metal ion concentration is determined by the use of a

metal electrode, or the amine concentration is determined by the measurement of the hydrogen ion concentration. In the present investigation, cells without liquid junctions were used for measuring the metal ion concentration in the presence of a large concentration of amine. The cells were of the type:

Ag | $AgNO_3$ + amine | Glass electrode | KI + amine | Ag/AgI.

The silver – silver iodide electrode was used as the reference electrode with a known concentration of potassium iodide. The potential of the glass electrode is a function of the hydrogen ion concentration. It can thus be made to cancel out if the amine concentration is effectively the same in each half-cell.

The iodide concentration in the reference cell was maintained at a concentration of approximately 0·01 molar and the Debye–Hückel equation for activity coefficients was applied[2]. This correction was applied to the metal ammine concentration in the calculation of the formation constants.

It must be noted that before the formation constant values can be taken as absolute, an exact knowledge of the standard potentials of silver and silver – silver iodide electrodes in the solvent used is required. In the calculations all that is necessary is a knowledge of the difference between these two potentials, and this was evaluated approximately as 0·982 volt from cells of the type:

Ag | $AgNO_3$ + H+ | Glass | KI + H+ | Ag/AgI.

The values of the formation constants are given in the accompanying table. To act as a check on the method, the formation constant of the pyridine silver complex was measured in aqueous solution at 25° C. The value of log K_f found was 4·25, which is in excellent agreement with other measurements[3].

Amine	log $K_f \pm 0·03$
Acridine	4·41
Quinoline	4·10
*iso*Quinoline	3·89
Pyridine	3·82

The order of stability of the silver amine complexes is, acridine > quinoline > *iso*quinoline = pyridine. This is also the order of the mobile π-electron densities on the nitrogen atom[1].

The interpretation of the results may be approached in two ways. First, if the attraction were purely due to electrostatic ion-dipole forces, it would be expected that the more negative the charge on the nitrogen and surrounding carbon atoms, the greater would be the attraction. Furthermore, it appears that the pyridine complex should be less stable than the acridine complex, not simply because the nitrogen on the acridine has a greater electron density and hence negative charge than the nitrogen of pyridine, but also because the adjacent carbons in acridine are negative while those in pyridine are positive. Steric factors may also play a significant part in determining the stability.

Secondly, the more negatively charged an electronegative atom like nitrogen becomes, the lower the electron affinity. The amount of covalent bonding that will occur when the dipolar molecule approaches the ion will depend largely on the difference in electronegativity of the atoms to be bonded. As this difference becomes smaller, covalent bonding increases. Thus the silver acridine bond will be more covalent than the silver pyridine bond, and one would expect a smaller amount of dissociation in solution.

Measurements were also made with indole and pyrrole. A marked reduction in the concentration of silver ion occurred, and at first it was thought that this was due to the formation of complex ions. Experiments have shown, however, that this is doubtful and that reduction to silver is the most probable process. The pyrrole solutions also after some time appear red. Studies of the absorption spectra of nickel – pyrrole solutions showed that negligible complex formation had occurred. The reactions of cations with pyrrole and indole appear complex. Thus the hydrogen, mercuric and cupric ions cause rapid polymerization, whereas silver ions are reduced to silver rapidly, in hot concentrated solutions, and with nickelous, manganous and zinc ions no reaction occurs on prolonged boiling. Pyrrole is known to form salts with certain metal ions[4].

Whatever other factors are involved, the present results indicate that a large electron density on the nitrogen of the amine leads to stability of the metal ammine.

I should like to express my gratitude to Prof. H. N. Parton and Mr. J. Vaughan, of Canterbury University College, and Prof. F. G. Soper, of this University, for much helpful discussion.

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Sigma Phase in Vanadium–Nickel Alloys

An X-ray examination has been made of a vanadium–nickel sigma phase single crystal containing 60 atomic per cent vanadium. The crystal was of irregular shape and plate-like form, the two larger dimensions being greater than ½ mm. Laue and rotation photographs using copper radiation showed that the unit cell was tetragonal with $a = 8·95$ kX. and $c = 4·63$ kX. The crystal was mounted with an a axis vertical, and 15° oscillation photographs were taken in a 6-cm. camera using unfiltered copper radiation and filtered chromium K_α-radiation. The photographs covered a range of 99° with 3° overlaps, and three films in series were used to give an adequate intensity range. From the copper photographs the systematic absences were found to be $(0kl)$ reflexions with $k + l$ odd, thus restricting the space group to $P4/mnm$, $P4mn$ or $P\bar{4}n2$.

These results are in agreement with those of previous workers for the iron–chromium sigma phase[1] and the cobalt–chromium sigma phase[2,3]. Vanadium–nickel alloys have the advantage, however, that when chromium radiation is used there is an appreciable difference in the X-ray scattering power of the vanadium and nickel atoms. The two series of photographs were compared in an attempt to detect any ordering of the atomic positions.

Previous workers had shown that the structure was closely related to one in which the atoms were arranged in close-packed layers perpendicular to the c-axis. Bergman and Shoemaker[1] and Kasper, Decker and Belanger[3] considered the space group to

be probably $P4/mnm$; but Dickens, Douglas and Taylor[2] directed attention to the similarity of the sigma phase structure to that of beta-uranium investigated by Tucker[4], according to whom the space group is $P4mn$. We have compared observed structure factors with those calculated from the atomic parameters proposed by Kasper *et al.* and by Tucker up to the copper K_α limit. Owing to the considerable absorption error, this comparison was only approximate, but our results showed comparable values with those calculated from Tucker's structure for all but three reflexions, while there were a large number of reflexions which did not fit the other structure. We therefore conclude provisionally that for vanadium–nickel Tucker's parameters are approximately correct. We have also obtained structure factors from powder photographs of the vanadium–nickel alloy where an absorption correction could be applied, and here the correspondence was very good.

On several of the photographs a faint spot, apparently corresponding to the (001) reflexion, was observed. The result was repeated several times and the spot shape appeared satisfactory. A reflexion corresponding to (003) was also found on two occasions; but it was not reproducible, and still fainter spots corresponding to (061) and (201) were also observed. These results could not be confirmed definitely as no Weissenberg camera was available and longer exposures gave very heavy backgrounds; but they indicate a possible tendency to ordering in which the glide plane of symmetry is partially destroyed. A one-to-one atomic ratio would permit a fully ordered structure in which alternate layers (and sub-layers) are composed entirely of one kind of atom, and the strongest superlattice reflexions from this structure up to the chromium K_α-limit would be (001) and (003) followed by (021), (023) and (061), which include all the observed reflexions.

A fuller account of this work will be published elsewhere.

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Biological Synthesis of Lactose from Carbon-14 Glucose

The synthesis of lactose from glucose by tissue slices of active mammary glands has been successfully demonstrated by earlier workers[1,2], and arteriovenous blood-sampling experiments have made it highly probable on quantitative grounds that glucose is the only significant precursor of the disaccharide *in vivo*.

In the present study carbon-14 starch was prepared by photosynthesis and administered to lactating rabbits by stomach-tube. After six hours, milk was collected and its lactose isolated. The analytical results confirm the earlier conclusions on the derivation of lactose in a way less open to the objections which can be raised against results drawn from blood-sampling experiments (see Folley[3]); for it will be seen from the accompanying table that the specific activities of the carbon of the lactose samples, and of the glucose and galactose fractions prepared from them by acid hydrolysis, are all sensibly the same.

Specific Activity of Lactose, Glucose and Galactose Carbon (counts/min./infinite thickness sample, with standard error of count)

Exp. 1.	Lactose	224 ± 5·0
	Glucose (assayed as $BaCO_3$)*	210 ± 20·4
	Galactose	212 ± 5·1
Exp. 2.	Lactose	252 ± 5·0
	Glucose (assayed as $BaCO_3$)*	242 ± 13·5
	Galactose	245 ± 3·8
	Galactose (assayed as galactosazone)	237 ± 6·8

* The carbon dioxide obtained by yeast fermentation of acid hydrolysate of lactose was collected as barium carbonate.

We infer from this that both parts of the disaccharide molecule are formed in equal measure from the same source—glucose—and that, although other substances could be conceived as contributing to the synthesis, their role must be either quantitatively negligible, or involve their prior conversion to glucose itself; for, any precursor of galactose that was not equally a precursor of the glucose bound in the lactose molecule would necessarily have diluted the activity of the galactose formed in our experiments relative to the activity of the glucose with which it was combined.

While these experiments relate directly only to lactose formation in the rabbit, we feel that they lend support to the conclusion recently reached elsewhere[4] from entirely different premises, that even in the ruminant there is no need for postulating any precursor for lactose, other than glucose.

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Formation of a Ferric-Perchlorate Ion-Pair Complex

In the course of a spectrophotometric investigation of the hydrolysis of the ferric ion in solutions of ionic strength greater than unity, evidence was obtained that ferric ions entered into complex formation with perchlorate ions. Although it has hitherto been widely assumed that perchlorate anions form no complexes, such interaction might well be expected with the smallest (and most highly charged) cations. Further experiments carried out with approximately 10^{-4} M ferric perchlorate in 1–7 M perchloric acid solutions in the wave-length range 2600–3600 A. confirmed the preliminary observations and provided quantitative data for the process.

The existing results are best interpreted on the assumption that only one complex is formed according to the thermodynamic law:

$$K_c^0 = \frac{[Fe^{3+}ClO_4^-]\,[ClO_4^-]^2\,\gamma_c^3}{[Fe^{3+}]\,[ClO_4^-]^3\,\gamma^4} = \frac{[Fe^{3+}ClO_4^-]}{[Fe^{3+}]\,[ClO_4^-]\,F'}$$

where γ is the activity coefficient of ferric perchlorate on the basis that it dissociates completely, γ_c is the activity coefficient assuming complete dissociation to $[Fe^{3+}ClO_4^-]$ and $2[ClO_4^-]$, and the quantities in brackets are the molalities of the various species. The activity coefficients were corrected for the fact that they applied to mixed electrolyte solutions using Glueckauf's equation[1]. This, together with the assumption that the known activity coefficients of chromic and magnesium perchlorates are for the present purposes good approximations for those of the electrolytes $[Fe^{3+}]$ 3 $[ClO_4^-]$ and $[Fe^{3+}ClO_4^-]$ 2 $[ClO_4^-]$ respectively, in unmixed solutions, led to the equation:

$$\log F = -6 \times 0{\cdot}26 \sqrt[3]{\mu} + 0{\cdot}43\,\mu,$$

whence values of F were calculated. Further justification for the cube-root law will be given in a future publication by Glueckauf.

Using a method of calculation similar to that of Olson and Simonson in their work on the hydrolysis of the ferric ion[2], a value of $K_c^0 = 0{\cdot}475 \pm 0{\cdot}075$ was obtained which allowed the ultra-violet absorption spectrum of the $Fe^{3+}ClO_4^-$ complex to be determined.

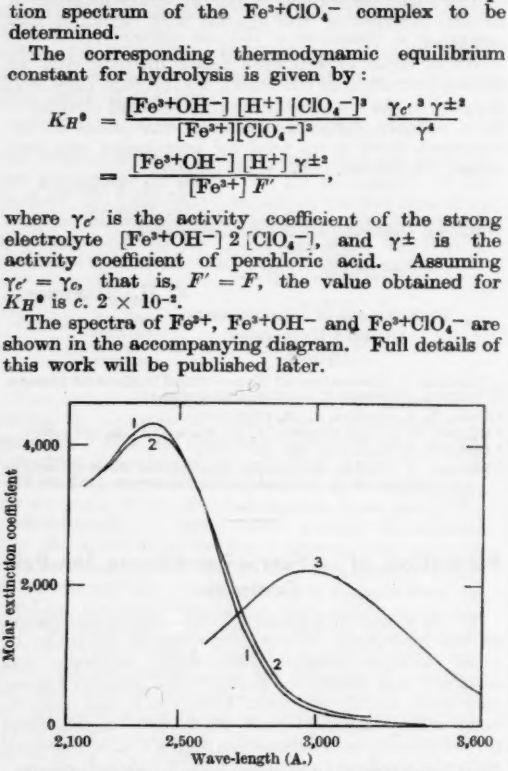
The corresponding thermodynamic equilibrium constant for hydrolysis is given by:

$$K_B^0 = \frac{[Fe^{3+}OH^-]\,[H^+]\,[ClO_4^-]^2}{[Fe^{3+}][ClO_4^-]^2} \cdot \frac{\gamma_{c'}{}^2\,\gamma_\pm{}^2}{\gamma^4}$$

$$= \frac{[Fe^{3+}OH^-]\,[H^+]\,\gamma_\pm{}^2}{[Fe^{3+}]\,F'},$$

where $\gamma_{c'}$ is the activity coefficient of the strong electrolyte $[Fe^{3+}OH^-]$ 2 $[ClO_4^-]$, and $\gamma_\pm$ is the activity coefficient of perchloric acid. Assuming $\gamma_{c'} = \gamma_c$, that is, $F' = F$, the value obtained for K_B^0 is *c.* 2×10^{-2}.

The spectra of Fe^{3+}, $Fe^{3+}OH^-$ and $Fe^{3+}ClO_4^-$ are shown in the accompanying diagram. Full details of this work will be published later.



Absorption spectra of the species (1) Fe^{3+}, (2) $Fe^{3+}ClO_4^-$ and (3) $Fe^{3+}OH^-$

Dodson[3] has recently shown that the reaction-rate for the exchange between Fe^{2+} and Fe^{3+} ions in perchlorate solutions is given by:

$$\text{Rate} = [Fe^{2+}]\,[Fe^{3+}]\left\{k_1 + \frac{k_2}{[H^+]}\right\},$$

and has obtained values for k_1 and k_2. He has interpreted his results as indicating that the exchange process takes place either directly between the two hydrated cations or via a triple ion complex $Fe^{2+}OH^-Fe^{3+}$, thus accounting for the two terms in the equation. It is possible that the first term is completely accounted for by the perchlorate complex $Fe^{2+}ClO_4^-Fe^{3+}$, a point which can be decided by experiment. If this proves to be the case, then the whole body of existing data on rates of ionic reactions in solution will need a thorough revision in order to determine the mechanisms which apply in various circumstances. The recent paper of Duke and Pinkerton[4] on the reduction of ferric iron by divalent tin in the presence of chloride ions represents the commencement of such a project.

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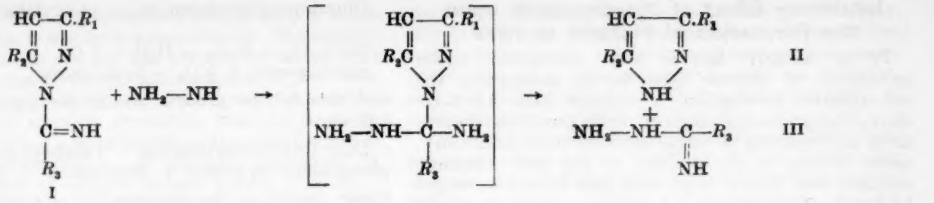
A New Route to Substituted Guanidines

In a recent communication[1], the reaction between hydrazine and a 1-formimino-pyrazole (I) was reported. It was found that molecular cleavage resulted, the products being a substituted hydrazine and a 1-unsubstituted pyrazole. This rearrangement occurs either by cleavage of the 1-substituent with its attachment to the hydrazine (mode *A*), or by initial ring opening, with subsequent displacement of the aminoguanidine derivative from the resulting hydrazone (mode *B*).

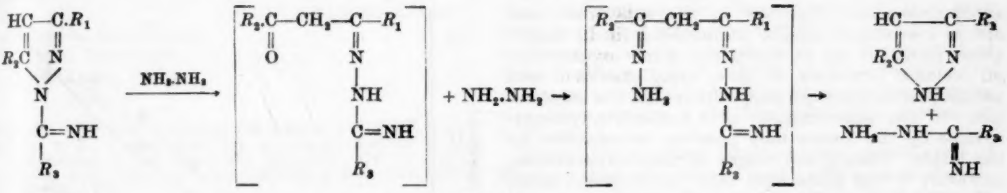
Using hydrazine itself, the products by either of these schemes are identical. With an asymmetric hydrazine, however, the results by mode *A* would be, for example, with phenylhydrazine, a pyrazole derivative containing a free imino group in the 1-position, and a phenyl-substituted aminoguanidine; whereas by mode *B* a 1-phenyl pyrazole and an unsubstituted aminoguanidine would result. Using 3,5-dimethyl-1-carbamadine-pyrazole nitrate (I, $R_1 = R_2 = CH_3$, $R_3 = -NH_2.HNO_3$) and phenylhydrazine, 3,5-dimethyl-pyrazole (II, $R_1 = R_2 = CH_3$) and anilinoguanidine nitrate (IV) were obtained; the reaction therefore is that described in mode *A*.

This hydrazinolysis could be formulated as a protolytic condensation as follows. (This formulation does not necessarily imply that this procedure is the most correct sequence of changes, but is intended merely to represent the type of reaction occurring.)

The possibility of this sequence taking place, then, depends evidently upon the attack of the substituted hydrazine anion on the carbonium ion; the more electrophilic the latter, then the more readily will addition take place. The electrophilic activity of this carbon atom is directly dependent on its attached groups. To define more accurately, therefore, the conditions and range of this hydrazinolysis, we are investigating the reaction between substituted hydrazines of alkyl, aryl and heterocyclic types with 1-formimino-substituted pyrazoles, (I, where R_3



Mode *A*

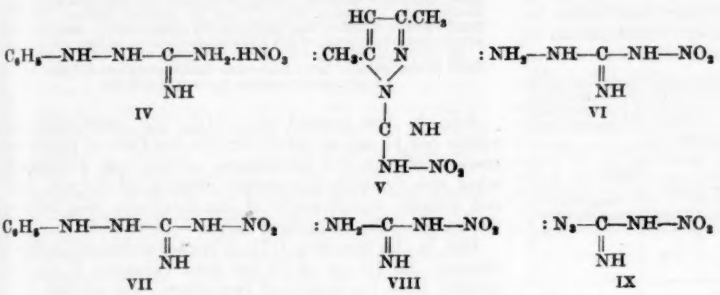


Mode *B*

varies from —NH—NO_2, to —NHCOC_6H_5, to —NHCONH$C_{10}H_7$, to —NHCSNHC_6H_5, and to —NH$SO_3C_6H_4CH_3$ (*p*)).

Similarly, 3,5-dimethyl-1-nitrocarbamyl-pyrazole (V)—a member of a new class, the 1-nitrocarbamyl type of pyrazoles, recently synthesized[2] in this laboratory—reacts with (*a*) hydrazine hydrate giving 3,5-dimethylpyrazole and nitroaminoguanidine (VI), and (*b*) with phenylhydrazine giving 3,5-dimethyl-pyrazole and 4-phenyl-1-nitroaminoguanidine (VII). It may be mentioned that this reaction is not confined to hydrazines, and it has been shown that with ammonia the 1-nitrocarbamyl class gives nitroguanidine (VIII) and a 1-unsubstituted pyrazole. Incidentally, phenyl-nitroaminoguanidine has also been synthesized[3] in this laboratory, by the reaction of nitroguanyl azide (IX) and phenylhydrazine. Similar hydrazinolyses to those described above appear also to have taken place when the 1-nitrocarbamyl pyrazole is treated with thiosemicarbazide and semicarbazide.

This facile and smooth hydrazinolysis should prove of considerable synthetical value in the preparation of such substituted aminoguanidines.



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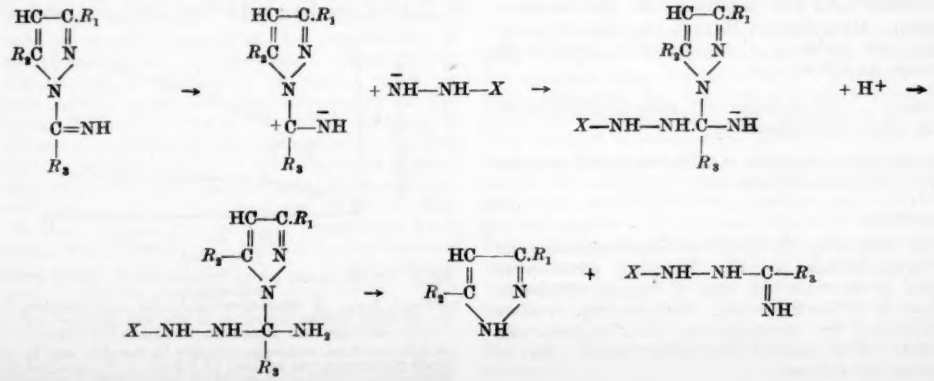

Inhibitory Effect of Xanthopterin upon the Formation of Melanin *in vitro*

It is already known that riboflavin, under irradiation of shorter light waves, accelerates the autoxidative production of melanin from 3,4-dihydroxyphenylalanine (dopa)[1], while pteridine derivatives are reported by many authors[2] to be inhibitory, more or less, to the activity of the milk xanthine oxidase, and Totter[3] says that this inhibition might be due to an antagonistic interaction of pteridine and *iso*alloxazine rings. Since my co-workers and I have been interested in the reactions of melanin and xanthopterin-like pigments in the silkworm[4], and also in a seemingly similar phenomenon in the wasp[5], these facts led me to carry out some experiments on melanin formation *in vitro*, using riboflavin and xanthopterin, upon the supposition that the acceleration of the autoxidation of 3,4-dihydroxyphenylalanine by the former may possibly be cancelled by the latter. During the course of these experiments, however, it was discovered that xanthopterin alone will inhibit the autoxidation of dihydroxyphenylalanine.

The autoxidation of a solution of dihydroxyphenylalanine proceeds with considerable rapidity during exposure to light or in the dark, as could be recognized by the progressive appearance of a dark red and then a brown colour in the solution. When xanthopterin (synthetic xanthopterin was obtained by the courtesy of Dr. Satoru Kuwada, of the Takeda Pure Chemicals, Osaka) is added beforehand to the dihydroxyphenylalanine, the coloration proceeds apparently very slowly. Thus, by the use of a colorimeter, a marked difference in the rate of oxidation was estimated. Titrations with potassium permanganate, which decomposes melanin, reveal the inhibitory activity of the xanthopterin, as is shown in the accompanying table. In all this work special care was taken to prevent errors due to differences of concentration of sodium ions in the experimental and control solutions.

Quantities of Melanin formed from Dihydroxyphenylalanine with or without Xanthopterin, in Light and Dark, as measured by the Volume of *N*/50 Potassium Permanganate Solution required to Decompose the Product, after Incubation for 17 hr. at 37·5° C. and *p*H 7·3

Conditions	Light		Dark	
Starting material	Dopa	Dopa and xanthopterin	Dopa	Dopa and xanthopterin
Volume of *N*/50 $KMnO_4$ (c.c.)	3·4	3·0	3·2	2·8

The next question is how and at what step the xanthopterin acts as inhibitor of the melanin formation. According to Raper[6], the conversion of tyrosine into melanin is accomplished roughly in three steps as follows:

(I)
tyrosine → 5,6-quinone of dihydroindole-carboxylic acid (red substance);
(II)
→ 5,6-dihydroxyindole; 5,6-dihydroxyindole-carboxylic acid (leuco-substances);
(III)
→ melanin.

As the first step (I) involves dehydrogenation of dihydroxyphenylalanine, the Warburg manometer was used to estimate the rate of oxygen uptake in the presence of xanthopterin. Results (Fig. 1) show no inhibition by xanthopterin, and suggest the occurrence of a coupled oxidation which can be formulated as follows:

Dihydroxyphenylalanine → phenylalaninequinone + 2H,

$2H + O_2 \rightarrow H_2O_2 \rightarrow H_2O + \frac{1}{2} O_2$,

xanthopterin + $\frac{1}{2} O_2$ → leucopterin;

and the whole process would be represented as follows:

Dihydroxyphenylalanine + xanthopterin + O_2 → phenylalaninequinone + leucopterin + H_2O.

Paper partition chromatography revealed the production of leucopterin from xanthopterin in this reaction.

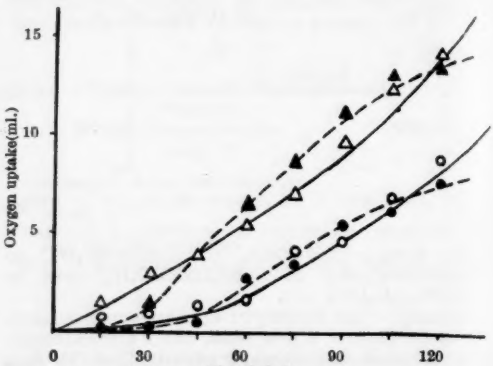

Fig. 1. Oxygen uptake by 3,4-dihydroxyphenylalanine with or without xanthopterin. —o— (in the light); —●— (in the dark): 1 c.c. of 30 mgm. per cent dihydroxyphenylalanine (la Roche), 0·5 c.c. of *M*/15 phosphate buffer solution, 0·5 c.c. of a solution prepared by diluting 0·5 c.c. each of *N*/10 hydrochloric acid and *N*/10 sodium hydroxide to 10 c.c., and 0·5 c.c. of distilled water.
— Δ — (in the light); —▲— (in the dark): 1 c.c. of 30 mgm. per cent solution of dihydroxyphenylalanine, 0·5 c.c. of *M*/15 phosphate buffer solution, 0·5 c.c. of 30 mgm. per cent solution of xanthopterin (Takeda), and 0·5 c.c. of distilled water. The xanthopterin solution was prepared by dissolving 3 mgm. of xanthopterin in 0·5 c.c. of *N*/10 sodium hydroxide, adding 0·5 c.c. of *N*/10 hydrochloric acid, and diluting the whole to 10 c.c.
Each of the wells in the manometric flasks contained 0·5 c.c. of 10 per cent potassium hydroxide solution

Also in the second step (II), the xanthopterin seems not to act as inhibitor, for the rate of decolorization of the red substance, which was prepared after the tyrosine–tyrosinase method of Raper, did not change significantly if xanthopterin was introduced into the Thunberg tubes beforehand.

But in the last step (III) a considerable inhibition occurs. To 40 c.c. of 75 per cent tyrosine, 3 c.c. of potato juice (as source of tyrosinase) was added, *p*H being kept at 6·0; the mixture was incubated at 25° C. until the dark red colour developed, and, after

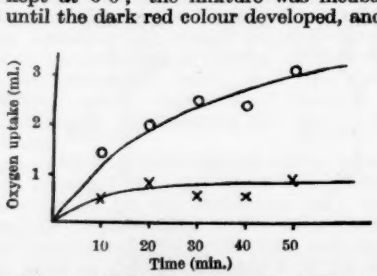

Fig. 2. Oxygen uptake by the 'leuco-substance' with or without xanthopterin.
—×—: 2 c.c. of leuco-substance in the main chamber, 0·5 c.c. of *N*/500 sodium hydroxide in the side arm, and 0·5 c.c. of 10 per cent potassium hydroxide in the well.
—o—: sodium hydroxide solution in the side arm in the above preparation was replaced by 0·5 c.c. of 30 mgm. per cent xanthopterin solution (dissolved in *N*/500 sodium hydroxide)

the addition of the hydrochloric acid to stop activity of the enzyme, it was boiled and filtered. The slightly yellowish filtrate, which was proved by an evident Ehrlich reaction to be the leuco-substance, was used as the starting material of the third step. A marked retardation of melanin formation was observed, by the use of Dubosq's colorimeter, in the solution which contained xanthopterin. It was also confirmed by the comparison of oxygen uptake curves (Fig. 2).

Further details of this inhibitory mechanism and effects of other pteridine derivatives are now being studied.

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Reductive Cleavage of Cytochrome c

CYTOCHROME *c* is the only well-characterized natural hæm – protein compound which, in the presence of excess acid acetone, is not split into hæmatin and protein. The stability of the hæm – protein link in cytochrome *c* was further emphasized when Hill and Keilin[1] attempted to prepare the unmodified porphyrin of the component. In the presence of reducing agents in acid solution iron is removed, leaving an ether-insoluble porphyrin which has been shown[2,3] still to contain peptide groups. From a study of this 'porphyrin *c*', Theorell[4] concluded that in native cytochrome *c* the hæm is bound to the protein not only by linkage to the iron, but also by stable thio-ether linkages connecting the α-carbon atoms of side-chains 2 and 4 of protoporphyrin with two terminal l-cysteine residues of the protein.

Peters and Wakelin[5] have shown that some stable thio-ether linkages are readily split by silver salts in mildly acid solution. Paul[6,7] has applied this method to cytochrome *c* and has obtained quantitative yields of hæmatohæmatin, thus providing further evidence in favour of Theorell's interpretation.

The effect of sodium amalgam on cytochrome *c* has now been examined. Schumm[8] used sodium amalgam as a mild reagent in the preparation of protoporphyrin from protohæmatin, where it is essential to avoid the action of strong acids or reducing agents upon the vinyl side-chains of the porphyrin. When 7 ml. of a $3{\cdot}0 \times 10^{-4}$ *M* solution of cytochrome *c*, prepared by the method of Keilin and Hartree[9], is shaken with 1·5 ml. of dilute sodium amalgam in an evacuated Thunberg tube, the solution is decolorized in about three minutes at 20° C. The tube is then opened, the solution transferred to a separating funnel where it is layered with a mixture of glacial acetic acid and ether (1 : 7 v/v) and allowed to stand in diffuse daylight for three hours. This time is usually adequate for the re-oxidation of porphyrinogen. Three extractions with the acetic acid – ether mixture then remove the porphyrin formed. The ether phase shows the absorption spectrum of a neutral porphyrin and chlorin. The porphyrin was identified by its spectroscopic properties, acid number and insoluble sodium salt as mesoporphyrin. No other porphyrin could be detected, and the yield, estimated spectrophotometrically as acid porphyrin, was 45–55 per cent.

Under similar conditions, protohæmatin yields only protoporphyrin with a trace of chlorin, confirming that the unmodified vinyl groups are not reduced by sodium amalgam. With hæmatohæmatin, on the other hand, the corresponding α-hydroxyethyl side-chains became saturated to give mesoporphyrin. Of the other hæm – protein compounds tested, horse liver catalase yielded only protoporphyrin. A solution of ox hæmoglobin, freshly prepared by the method of Adair[10], gave a mixture of proto- and meso-porphyrins in the proportion 15 : 1. The corresponding proportion after storage of the hæmoglobin for a week at 4° C. was 5 : 1.

These observations support the conclusion of Theorell that side-chains 2 and 4 of the hæm of cytochrome *c* are involved in the stable hæm – protein linkage if it is assumed that sodium amalgam brings about a reductive splitting of these links with the simultaneous removal of iron. The presence of appreciable amounts of mesoporphyrin in the products of the reaction with hæmoglobin suggests the possibility that during preparation and storage the vinyl side-chains of the protohæmatin prosthetic group may undergo a progressive modification in such a way as to render them capable of reduction under the conditions used. I wish to thank Dr. A. R. H. Trim for a gift of catalase, and Dr. R. Hill for valuable advice.

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Changes in the Distribution of Nitrogen during the Composting of Straw

DURING the decomposition of straw on composting with inorganic nitrogen, there is an increase of nitrogen in a water-insoluble form[1,2]. Earlier workers[2] have estimated the amount of protein synthesized using the conventional factor 'protein' = 6·25 × N. This method of calculation, although useful in preliminary investigations, is open to criticism when non-protein nitrogen is present. Several other methods have been used for following changes on composting or storing manure. Russell and Richards[3] showed that little change occurs in the amide nitrogen of farmyard manure on storage. Ashworth[4] used the scheme of 'proximate' analysis of Waksman and Stevens[5] to follow changes in the nitrogen compounds in straw composted with dried blood as a source of nitrogen. He did not determine changes in amide or amino nitrogen.

I have investigated the relation between soluble and insoluble nitrogen fractions in several composts by the following scheme :

Fresh compost

extract overnight with cold 0·1 *N* hydrochloric acid

Fraction *A* : insoluble nitrogen
(i) Acid-soluble nitrogen (soluble in 6 *N* hydrochloric acid in 16 hr. at 100° C.)
(ii) Dilute acid-soluble nitrogen (soluble in 2 per cent w/v hydrochloric acid in 5 hr. at 100° C.)
(iii) α-Amino nitrogen in *A* (i)
(iv) Amide nitrogen (hydrolysis with 4 per cent w/v hydrochloric acid for 10 hr. at 100° C.)

Fraction *B* : soluble nitrogen
(i) Total nitrogen
(ii) Ammonia nitrogen
(iii) Nitrate nitrogen

'Dilute acid-soluble nitrogen' was determined by the method of Waksman and Stevens (ref. 5).

Preliminary experiments established that the optimum conditions for hydrolysis of the protein nitrogen present to α-amino nitrogen were by heating for 16 hr. with 6 *N* hydrochloric acid at 100° C. α-Amino nitrogen was determined by decarboxylation with ninhydrin[6] after removal of humin and ammonia. For the determination of amide nitrogen the method finally adopted was very similar to that recommended by Shore, Wilson and Stueck[7].

The results given in the accompanying table illustrate the changes in a compost prepared from sewage sludge and wheat straw.

Fractionation of Nitrogen in a Sludge-Straw Compost. (Results as Percentage of Total Nitrogen)

Fraction	Days from start				
	0	9	44	114	471
Water-soluble :					
Total nitrogen	19·9	21·25	2·4	5·9	12·9
Ammonia nitrogen	2·0	18·4	0·65	1·6	0·25
Nitrate nitrogen	nil	nil	nil	2·5	12·3
Water-insoluble :					
Acid-sol. nitrogen	62·6	58·1	76·3	75·9	63·9
Dil. acid-sol. nitrogen	40·6	37·5	54·6	53·1	40·4
α-Amino nitrogen	50·8	37·2	46·9	40·8	40·2
Amide nitrogen	11·0	7·4	10·6	10·4	8·7

Ratio sludge (dry matter) to straw (dry matter) 2 : 1. Initial nitrogen, 2·44 per cent (dry matter). Moisture, 65 per cent.

It appears that in composting straw with a source of slowly available nitrogen (sewage sludge), there was a simultaneous ammonification of soluble nitrogen originally present and deamination of part of the original protein. The subsequent increase in soluble nitrogen in the mature compost was a very slow process, which was accompanied by a parallel slow decrease in the fractions of the insoluble nitrogen.

Fuller details of these changes, and the results obtained with straw composted with inorganic nitrogen, will be published later.

This work was carried out with the aid of a special grant from the Agricultural Research Council, to which grateful acknowledgment is made.

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Mode of Action of Growth Regulators in Plants

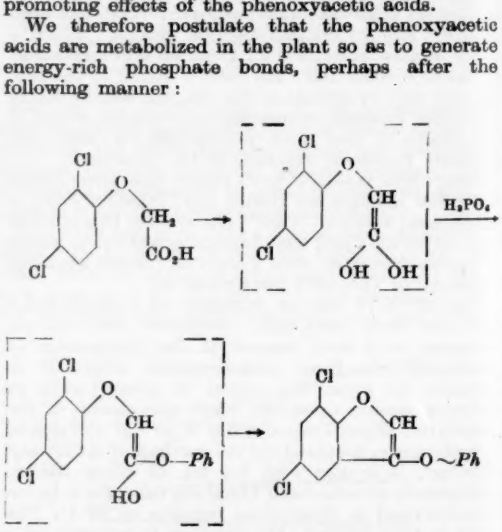
Hansch and Muir[1] have shown that a free ortho position is required for growth regulatory activity in the phenoxyacetic acid series (*Avena* straight-growth test), and have suggested that the active compound reacts "with a substrate at two points, first by means of the carboxyl group, and second at a position ortho to the attachment of the carboxyl group". This explanation does not account for Wain's finding[2] that one hydrogen on the α-carbon atom was essential for activity (Went pea test).

We believe that the free ortho position permits cyclization and that the hydrogen on the α-carbon affords a requisite tautomeric structure[3].

Now, Loofbourow[4], working with yeast, concluded that "the proliferation-promoting effect of products from damaged cells appears to be due to a variety of substances, among which are known growth factors and adenine nucleotides", and that, "addition of adenosine triphosphate (ATP) produced the same effect as addition of the damaged cell products". It is therefore of interest that Bonner[5] has stated : "That arsenate interferes with the metabolism of phosphate in the *Avena* coleoptile is indicated by the fact that the arsenate inhibition of growth substance (indole acetic acid) action may be relieved by the further addition of phosphate to the tissue. The influence of arsenate in inhibiting the effect of added growth substance is a competitive one and depends upon the ratio between added phosphate and added arsenate. These observations suggest, then, relationships between growth substance metabolism and the utilization of energy-rich phosphate produced in respiration."

We have thus surmised that the high-energy phosphate bond may also be involved in the growth-promoting effects of the phenoxyacetic acids.

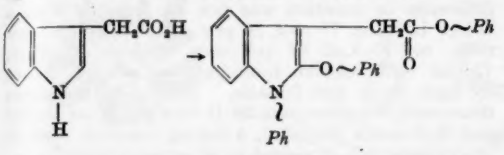
We therefore postulate that the phenoxyacetic acids are metabolized in the plant so as to generate energy-rich phosphate bonds, perhaps after the following manner :



Ph = H_2PO_3 and ~ = high energy bond

This mechanism would require a free ortho position, a mobile hydrogen atom situated on the α-carbon, and, in the presence of inorganic phosphate, the formation of an ester phosphate linkage. On cyclization, the energy-rich enol phosphate linkage is generated.

We may now consider the role of the natural plant growth regulator, indole-3-acetic acid, in the above light. There are three possible high-energy bonds.



Of these, only the enol phosphate seems likely to be generated directly from inorganic phosphate and extracellularly-added indole-3-acetic acid. The carboxyl-phosphate and the *N*-phosphate, in such circumstances, could probably not be formed except by transphosphorylation from adenosine triphosphate, which, however, would not result in the generation of energy-rich phosphate. But, if indole-3-acetic acid is synthesized from tryptophane in plants, the energy-rich carboxyl-phosphate bond might be generated by oxidative decarboxylation of a possible intermediate indole-pyruvic acid.

Whatever the mechanism involved, the point we wish to make is that the metabolism of indole-3-acetic acid or its precursors may generate energy-rich phosphate bonds, and that this access of energy may be the prime factor in the initiation of the growth response.

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Importance of the 'Counter Current Principle' for the Oxygen Uptake in Fishes

According to van Dam[1], the high utilization of oxygen in fishes is due, among other things, to the circumstance that in the gills water and blood flow in opposite directions. The question rises whether this hypothesis can be verified experimentally. The direction of the blood stream in the gill lamellæ is not liable to changes; that of the water current, however, can be reversed.

We carried out some experiments with tench of about 16 gm., narcotized with 0·7 per cent ethyl urethane until the movements of the opercula had just stopped. The mouth of the fish was tied to a piece of rubber tubing. We verified that no water could pass between lips and tubing by suspending some India ink in the water passing through the latter.

Water was pumped through the tubing by means of a small pump, driven by a synchronous motor with a variable retarding attachment. The direction of the water stream could be reversed at any moment by starting the motor in the opposite direction.

At one side of the fish the gills were put out of action by pressing the operculum against the body wall. The volume of water driven along the gills of the other half of the body was exactly known. At the beginning of each experiment we worked with opposite currents, and regulated the velocity of the water stream in such a way that the utilization of oxygen amounted to 50–70 per cent. Afterwards the direction of the water current was reversed, and the utilization determined again. Repeatedly we verified at a magnification of about twenty times that the abnormal direction of the water stream caused no observable change in the position of the gill lamellæ. Therefore, the results of our experiments cannot be ascribed to a modification of the area of contact between water and gills. Finally, in some cases, we returned to opposite currents at the end of the experiment, and once more determined the utilization. The results of the experiments are summarized in the accompanying table.

The variation among individual experiments is considerable. Nevertheless, the difference in utilization during opposite currents and during parallel currents is quite evident. Averaging over all the experiments, we find for thirty-two cases of opposite currents a mean utilization of 51 per cent, and on the other hand for twenty-five cases of parallel currents a mean utilization of 9 per cent. In other words, these experiments show that the 'counter current principle' is of high importance for the efficiency of the fish gill, and no doubt for that of other gills as well.

Exp. No.	Weight of fish (gm.)	Velocity of water stream (c.c./sec.)	Temp. (° C.)	Utilization of oxygen (per cent)		
				opp. dir.	same dir.	opp. dir.
1	13·2	0·16	21	28	3; 5	17
2	19·3	0·16	18	88	28; 17	87
3	19·3	0·16	16	57	6; 5	76
4	19·3	0·16	16	75	18; 13	50
5	19·3	0·16	16	69	4	
6a*	19·3	0·16	16	88; 89; 92		
6b					4; 6; 5; 3	
6c						26; 31; 31; 33
6d						53; 47; 44; 42
7	16·1	0·16	18	36; 43	1; 5	
8	19·3	0·16	18	38; 34	6; 3	
9	16·1	0·16	18	54; 46	21; 4	
10	16·1	0·15	18	39; 31	6; 8	
11	16·1	0·15	18	50; 61	13; 16	
12	16·1	0·15	17	44; 45	19; 15	

* Expt. 6*a*, *b*, *c* and *d* were carried out on different days.

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Humidity Reaction in *Drosophila melanogaster*

In an investigation on the chemoreceptivity of *Drosophila melanogaster* (Oregon), Begg and Hogben[1] stated that the normal undesiccated males of this species showed a response to moisture if the difference in relative humidity exceeded 50 per cent. In the desiccated males the reaction grew more pronounced. The preferred relative humidity was reported to be about 90 per cent. No response to humidity differences was observed in normal or desiccated females.

Using a technique modified from the methods of Gunn and Kennedy[2], and Wigglesworth[3], we have studied the reactions of *Drosophila melanogaster* (Berlin Wild) and obtained results which differ greatly from those obtained with Oregon flies by Begg and Hogben. In our experiments, comprising more than 70,000 position records with about 5,000 specimens, a clear reaction to humidity differences was observed both in males and females, the reaction being stronger in males. Even the smallest difference in humidity used, namely, 3 per cent, was clearly perceived at the moist end of the humidity range by both males and females. Begg and Hogben observed a reaction towards the drier side only in the antennaless mutant, and based their conclusions concerning the humidity receptors on the difference in reaction between the normal fly and this mutant. In our experiments, the reaction of the normal flies towards the drier or moister side depended on the humidities used. If two humidities at a time were available to the flies, both high (100, 97 and 87 per cent relative humidity) and low (0, 20, 34 per cent relative humidity) humidities were constantly avoided, provided the humidity difference in question was not too great. With a choice between 77 and 34 per cent, 77 and 67 per cent, or 77 and 87 per cent relative humidity, 77 per cent relative humidity was always chosen by both males and females. When the flies were desiccated over silica gel at 26° C. for three hours (males) and five hours (females), a strong reaction towards the moister side appeared in all experiments.

The accompanying graph shows that the intensity of the reaction is dependent on the degree of desiccation. Normal undesiccated females, given the choice between 100 and 34 per cent relative humidity, show a reaction towards the drier humidity, females desiccated for 3 hr. at 26° C. show a moderate response towards moist conditions, but females desiccated for 5 hr. display a very strong moist reaction; the males, on the other hand, need only 3 hr. desiccation to reach the same high intensity of reaction. It was noted that, when desiccated at 26° C., the males died earlier and the percentage loss of weight was more rapid in males than in females.

Work on further problems of the humidity reactions in *Drosophila melanogaster* is in progress and the results will be published in fuller detail elsewhere.

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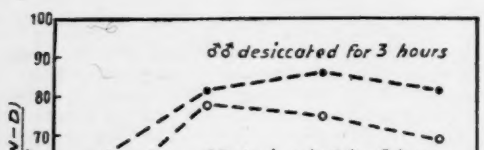

Intensity of humidity reaction in *Drosophila melanogaster* at 20° C., expressed as excess percentage, *W* representing the number of position records on the moister side, *D* the number on the drier side and *N* the total number of position records. Humidity difference 100–34 per cent relative humidity. Each line represents 960 position records. For the controls, 100–100 per cent relative humidity, the value never exceeded 6 per cent

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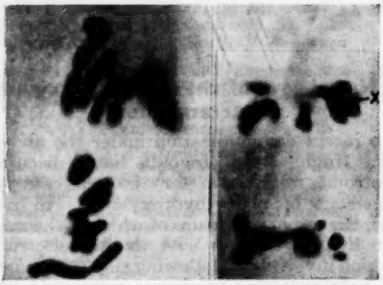
X and neo-*Y* Mechanism of Sex-Determination in the Grasshopper, *Thisiocetrus pulcher*

A number of instances of *X* and neo-*Y* mechanism of sex-determination is now on record in the Acrididæ[1]. The purpose of the present communication is to record a further case found in the grasshopper, *Thisiocetrus pulcher* of the subfamily Catantopinæ, collected in the area adjoining the Biology Departments of the University of Calcutta. Only two male individuals could be found, on two separate occasions, in spite of extensive search. The observations reported here, therefore, are from sectioned preparations of the testes of the first, and Feulgen squash preparations of the testes of the second, specimen. A large number of dividing cells was obtained in both of them, which enabled us to study the behaviour of the sex chromosome complex during spermatogenesis.

Many clear spermatogonial metaphase plates show that the diploid number is 22 (Fig. 1). The primary constrictions are very much pronounced in all the chromosomes. One of the chromosomes on the plate is V-shaped, the two arms being unequal, and the rest have sub-terminal centromeres. The metacentric chromosome when examined from nuclei in early spermatogonial divisions (Fig. 2) shows that the shorter arm is negatively heteropycnotic (a feature which seems to be universal for the *X*-chromosome of the Acrididæ), whereas the other arm is stained like the rest of the chromosomes in the complement. It is evidently formed by the fusion of the *X*-chromo-

(1)

(2) (3) (4)



(5) (6)

(1) Spermatogonial metaphase plate with 22 chromosomes; the metacentric chromosome is the *X*. (2) The *X*-chromosome from an early spermatogonial metaphase plate. (3) The *XY* bivalent at diplotene. (4) The same at diakinesis. (5) Photomicrograph of a binucleate cell at metaphase I. (6) Anaphase I; only the *X*-chromosome is seen, the *Y* being out of focus. × *c.* 1,350

some with one member of an autosome pair giving rise to the V-shaped neo-*X* chromosome in the species.

At the diplotene stage, the longer arm of the neo-*X* associates terminally with an autosome forming a bivalent (Fig. 3). The latter is the homologue of the former and is the neo-*Y* chromosome (Fig. 3, *Y*). The shorter arm of the *X* (Fig. 3, *XS*), like the normal *X*-chromosome of Acrididæ, is positively heteropycnotic at this stage. Numerous diplotene nuclei, especially the earlier ones, were examined, but not a single instance of interstitial chiasma in the *XY* bivalent could be detected. The reason for this is perhaps to be sought in the heteropycnosis of the neo-*Y* at diplotene. It generally takes up a deeper stain (Fig. 3, *Y*) than the long arm of the *X* (Fig. 3, *XL*) and the autosomes. This positive heteropycnosis of the neo-*Y* is not a constant feature, and in some nuclei it appears to be stained like its homologue. Similar behaviour of the *Y* is also found in the diakinesis stage, where it is more deeply stained than the long arm of the *X* (Fig. 4, *XL*). The *Y*-chromosome is not only different from the long arm of the *X* in its staining reaction in the diplotene and the diakinesis nuclei, but also smaller in size. Fig. 5 is a photomicrograph of a binucleate cell at metaphase I with two separate spindles. The structure of the *XY* bivalent is very characteristic, and the *Y*-chromosome as well as the two arms of the *X*-chromosome are equally stained and are similar to the autosomes in this respect. That the *X*-chromosome is metacentric with two unequal arms is further confirmed at the anaphase stage of the first meiotic division when the *X*-chromosome (Fig. 6, *X*) passes to one pole of the spindle in a bipartite condition. The *X*- and the *Y*-chromosomes divide equationally at the second meiotic division.

McClung[2] records that different individuals of the grasshopper, *Hesperotettix viridis*, may be either *XO* or *XY*, thus showing that the *XY* condition is not yet fully established in that species. We were not able to extend our observations to many more individuals and prove definitely that the *XY* condition is present in all the members of the species; but the difference in the nucleation cycle of the neo-*Y* and its homologue, namely, the long arm of the *X* coupled with the shorter length of the former, indicates strongly that the *XY* mechanism is fully established in the species, because such differences cannot arise at a single step. A long period must, therefore, have elapsed after the initial translocation giving rise to *XY* sex mechanism to allow for the heterochromatization of the neo-*Y* and also for further structural changes leading to the reduction in its size.

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Longevity of *Marsilea* Sporocarps

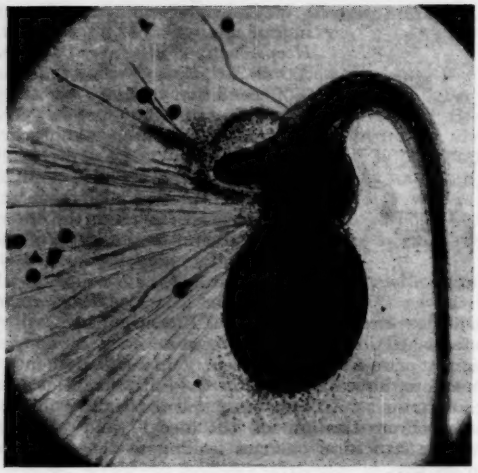
It is well known that the seeds of many angiosperms retain their power of germination for a considerable period, sometimes exceeding a hundred years. As an extreme case, it has been reported recently[1,2] that the viable seeds of *Nelumbo*, obtained by Ohga[3] from the bed of a dried-out Manchurian lake, are approximately a thousand years old.

The spores of most pteridophytes by contrast have a comparatively short life and often die within a year, although isolated cases of considerable longevity have been recorded[4,5]. Only the sporocarps of the heterosporous fern family Marsileaceæ approach the long-lived angiosperm seeds in this respect. As long ago as 1870 Braun[6] commented on the retention of viability by sporocarps of *Marsilea pubescens* thirty-two years old, while Chamberlain[7] describes the germination of poisoned herbarium specimens fifty years old, and even states that sporocarps which have been kept in 95 per cent alcohol for years germinate almost as quickly as those which have been kept in a dry box.

An examination of old herbarium sheets of *Marsilea* obtained from the Manchester Museum suggested that it might be of interest to test the viability of the sporocarps. Several species were studied and positive results were obtained in two cases: *M. vestita* Hook. and Grev.—from sheet labelled "Flora of Washington, W. N. Suksdorf, Nov. 1883"; *M. fournieri* C. Chr.—from sheet labelled "*M. minuta* Fourn. Plantae Mexicanae. C. G. Pringle, 20 May, 1890".

It is clear from these labels that the sporocarps of *M. vestita* were at least sixty-eight years old and those of *M. fournieri* 61½ years old.

The sporocarps were germinated under aseptic conditions, as described in a previous communica-



Marsilea fournieri. Macrospores and microspores four days after opening of sporocarps. Macrospore bears three-day embryo. Other details in text. (× 36)

tion[8], although such treatment is not necessary merely for the study of viability.

In both species, germination of the sporocarps followed the usual pattern, and the development of the micro- and macro-spores continued with characteristic rapidity, liberation of spermatozoids and fertilization being completed within twenty-four hours. Embryo development started at once, and examination forty-eight hours after the initial opening of the sporocarp revealed a distinct embryo with the first leaf pushing out the prothallial covering as a conical projection.

The accompanying photograph illustrates a three-day embryo of *M. fournieri*. The first leaf, on the right, has broken through the sheath formed from the prothallial tissue, while the first root, on the left, is still enclosed. A characteristic tuft of rhizoids, developed after fertilization, springs from the prothallus on one side only, and intermingled with the rhizoids are several germinated microspores. The original mucilaginous investment of the macrospore is revealed by the exceedingly numerous trapped spermatozoids. A three-day embryo of *M. vestita* is very similar. *M. fournieri* was selected for illustration since this is possibly the first account of the embryo of this species. The first leaf of *M. fournieri* is rather flattened as compared with the cotyledons of *M. drummondii* and *M. vestita*; but the shape is still approximately acicular and the leaf terminates in a delicate colourless prolongation as in the other two species.

The long dry period in storage of the sporocarps has thus had no apparent effect on development, which is still proceeding quite normally. As in more recently collected sporocarps, almost every spore has produced an embryo, and in this respect there has been no deterioration with age.

From these results it would seem that germination should still be possible at a considerably greater age, and reports of tests on other older collections will be awaited with interest. Alternatively, I should be pleased to carry out tests on any sporocarps sent in for this purpose. It should be remembered, however, that negative results are not necessarily conclusive, as even recently collected sporocarps have frequently failed to liberate viable spores in spite of their mature external appearance.

I am indebted to Mr. Ernest Ashby for taking the photograph.

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Department of Cryptogamic Botany,
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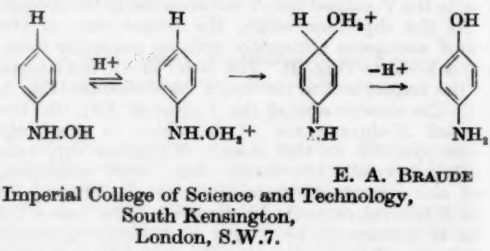
Dec. 12.

[1] Libby, W. F., *Science*, **114**, 291 (1951).
[2] *Nature*, **168**, 905 (1951).
[3] Ohga, I., *Amer. J. Bot.*, **13**, 754 (1926).
[4] Hartt, C. E., *Bot. Gaz.*, **79**, 427 (1925).
[5] Okada, Y., *Sci. Rep. Tohoku Imp. Univ.*, Biol., **4**, 127 (1929).
[6] Braun, A., *Monatsber. Berl. Akad.*, 653 (1870).
[7] Chamberlain, C. J., "Methods in Plant Histology", 4th ed., 266 (1924).
[8] Allsopp, A., *Nature*, **168**, 301 (1951).

A New View of the Arylhydroxylamine Rearrangement

In a recent communication under the above title, Heller, Hughes and Ingold[1] have discussed an anionotropic mechanism for the acid-catalysed rearrangement of phenylhydroxylamine to *p*-aminophenol, the essential feature of which is the migration of the hydroxyl group *with* its full electron octet and which involves the following steps: (i) conversion of the hydroxylamine into its conjugate acid, (ii) intermolecular migration of the hydroxyl group in the form of a water molecule, (iii) prototropic isomerization of the resulting iminoquinol and loss of a proton to give the aminophenol. This mechanism is identical in substance with that which I have previously put forward and expressed in the following formulæ[2]:



E. A. Braude

Imperial College of Science and Technology,
South Kensington,
London, S.W.7.

[1] *Nature*, **168**, 909 (1951).
[2] *Quart. Rev. Chem. Soc.*, **4**, 423 (1950).

Dr. Braude's published statement on the matter is short enough to be quoted: "It is very probable, however, that the acid-catalysed rearrangement of phenylhydroxylamine, and allied reactions, proceeds by way of successive pentad anionotropic and prototropic changes in the C : C.C : C.N skeleton, as originally suggested by Bamberger. The rearrangement may occur in two steps, the migrating group becoming first attached to the orthocarbon atom." At a later point he entertains the possibility that the rearrangement is intramolecular. This will make his position clear. We did not refer to it before, because we could accept it only in such a very partial way.

H. E. Heller
E. D. Hughes
C. K. Ingold

University College,
London, W.C.1.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Saturday, January 12

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mr. W. T. O'Dea: "Artificial Lighting prior to 1800 and its Social Effects".*

Sunday, January 13

SOCIETY FOR CULTURAL RELATIONS WITH THE U.S.S.R. (at Battersea Town Hall, Battersea, London, S.W.11), at 3 p.m.—"Man Conquers Nature—The New Soviet Construction Schemes".

Monday, January 14

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Prof. H. Godwin, F.R.S.: "Paleo-ecology, the Study of the Vegetation of Former Times" (Ramsden Memorial Lecture).*

SOUTH-EAST LONDON TECHNICAL COLLEGE (at Lewisham Way, Lewisham, London, S.E.4), at 7 p.m.—Mr. G. R. Leeds: "Diamond Dies".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Dr. Owen Lattimore: "The New Political Geography of Inner Asia".

Tuesday, January 15

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. R. B. Southall: "Llandarcy and Fuel Efficiency".*

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. Norman Brown: "The Patent Act of 1949".

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. H. Dingle: "The Philosophy of Science" ("The Scientific Basis of Medicine", 1).*
(Further Lectures on January 17, 22, 24, 29, 31, February 5, 7, 12, 14, 19, 21, 26, 28, March 4, 6, 11, 13, 18 and 20.)

Wednesday, January 16

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Scientific Papers.

ROYAL STATISTICAL SOCIETY, RESEARCH SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. K. D. Tocher: "The Design and Analysis of Block Experiments".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. A. F. Wilkins and Mr. C. M. Minnis: "Comparison of Ionospheric Radio Transmission Forecasts with Practical Results".

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. J. Cathala: "Unit Chemical Operations in Chemical Engineering".*
(Further Lectures on January 17 and 18.)

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (joint meeting with the LONDON AND SOUTH-EASTERN COUNTIES SECTION of the ROYAL INSTITUTE OF CHEMISTRY, at the Waldorf Hotel, Aldwych, London, W.C.2), at 6.30 p.m.—Prof. Kathleen Lonsdale, F.R.S.: "Recent Research in Chemical Crystallography".

OIL AND COLOUR CHEMISTS' ASSOCIATION, LONDON SECTION (at Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Messrs. F. Armitage, E. S. J. Fry and S. Kut: "Styrene Copolymers—Recent Work on the Course of the Reaction".

Thursday, January 17

BRITISH PSYCHOLOGICAL SOCIETY (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Mr. R. Conrad: "The Analysis of Skilled Behaviour—some Experimental Studies in Industry".

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. H. O. Schild: "What is Pharmacology?"*

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. D. Kear: "Mineralization at Castle-an-Dinas Wolfram Mine, Cornwall"; Mr. P. M. J. Gray: "The Production of Pure Cerium Metal by Electrolytic and Thermal Reduction Processes".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. F. Smithies: "Non-metric Topology".

COLLEGE OF PRECEPTORS (at 2 Bloomsbury Square, London, W.C.1), at 6 p.m.—Dr. A. Loveday: "Democracy—the New Insistence on Democratic Values" ("Horizons in the School", 2). (Joseph Payne Memorial Lectures.)*

BRITISH INSTITUTION OF RADIO ENGINEERS, SCOTTISH SECTION (in the Department of Natural Philosophy, The University, Drummond Street, Edinburgh), at 7 p.m.—Mr. G. L. Stephens: "Television Aerials".

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Dr. Ernest Muir: "The Treatment of Leprosy with DDS"; Dr. R. G. Cochrane: "The Action of Sulphones in Leprosy with particular reference to Histopathology".

Friday, January 18

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. S. Livingstone Smith: "Ship Research" (Thomas Lowe Gray Lecture).

MANCHESTER STATISTICAL SOCIETY, INDUSTRIAL GROUP (at the Albert Hall, Peter Street, Manchester), at 6.45 p.m.—Mr. W. F. L. Dick: "Limestone-Sampling—The Design of a Scheme for Bulk Materials".

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (in the New Physics Theatre, The University, Manchester), at 7 p.m.—Dr. L. A. Sayce: "Light Colour and Radiation".

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Dr. G. H. Visser: "Fine Chemicals and the Petroleum Industry".

CHEMICAL SOCIETY, GLASGOW SECTION (in the Chemistry Department, The University, Glasgow), at 7.15 p.m.—Prof. C. A. Coulson, F.R.S.: "The Contributions of Wave Mechanics to Chemistry" (Tilden Lecture).

Saturday, January 19

BIOCHEMICAL SOCIETY (at the Middlesex Hospital Medical School, London, W.1), at 10.30 a.m.—Scientific Papers.

BRITISH MYCOLOGICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Scientific Papers.

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mr. W. F. Grimes: "Archæology and Air Photography".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN ELECTRICAL INSTALLATION in the Department of Mechanical and Electrical Engineering—The Principal, Wigan and District Mining and Technical College, Wigan (January 18).

ASSISTANT LECTURER IN CHEMISTRY (with good honours degree, and research, industrial and/or teaching experience in organic chemistry) for teaching up to B.Sc. (special) standard—The Principal, Brighton Technical College, Brighton 7 (January 19).

CHEMICAL ENGINEERS, FUEL TECHNOLOGISTS, CHEMISTS and PHYSICISTS (in both senior and junior appointments)—The Industrial Relations Officer, West Midlands Gas Board, 6 Augustus Road, Edgbaston, Birmingham 15 (January 19).

PRINCIPAL SCIENTIFIC OFFICER (with a University degree of high standard in science or engineering, or equivalent qualifications, and extensive experience in aerodynamic research, especially in the transonic and supersonic fields) to initiate and be responsible for experimental research, both basic and applied, into problems of high speed flight; a SENIOR EXPERIMENTAL OFFICER (with a University degree in engineering, or equivalent qualifications, and considerable experience with engineering apparatus for aerodynamic research) to be responsible to a Principal Scientific Officer for work on the design and later for the operation and maintenance of large engineering apparatus for aerodynamic research; an EXPERIMENTAL OFFICER, Grade 3 (with a University degree or diploma in aeronautical engineering or physics, or equivalent qualifications, and experience in aerodynamic experimental work, preferably at high speeds) to assist a Senior Experimental Officer, experimental supersonics, in experimental work on problems of high speed flight; and a SCIENTIFIC OFFICER, Grade I (with a University degree of high standard in physics or electrical engineering, or equivalent qualifications, and some experience in instrument development, preferably electronic) to be responsible to a Senior Scientific Officer for the development of instruments for aerodynamic research and the adaptation of existing instruments for special purposes; in the Research and Development Branch at the High Speed Aerodynamics Laboratory at Adelaide—The Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S.W.1 (January 19).

SENIOR LECTURER IN ELECTRONICS in the Department of Physics and Mathematics—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (January 19).

PROFESSOR OF PATHOLOGY, BACTERIOLOGY and PARASITOLOGY at the Veterinary College, Dublin—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (January 22).

SCIENTIFIC OFFICERS (with a first- or second-class honours degree in engineering or physics) for work on problems connected with agriculture, and ASSISTANT EXPERIMENTAL OFFICERS, to assist the Scientific Officers in their work—The Secretary, National Institute of Agricultural Engineering, Wrest Park, Silsoe, Beds (January 22).

DEPUTY DIRECTOR OF HYDRAULICS RESEARCH (Senior Principal Scientific Officer grade) at Wallingford, Berks—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4114/52 (January 24).

ASSISTANT CHEMIST (B.Sc. or A.R.I.C.)—The Chief Engineer, Southend Waterworks Company, Treatment Plant and Laboratory, Langford, Maldon, Essex, endorsed 'Chemist' (January 26).

DIRECTOR (preferably with a University degree) OF THE WALKER ART GALLERY—The Town Clerk, Municipal Buildings, Liverpool 2 (January 26).

CHEMICAL TECHNOLOGIST IN THE DEPARTMENT OF INDUSTRIES, Ceylon—The High Commissioner for Ceylon in London, 13 Hyde Park Gardens, London, W.2 (January 29).

LECTURER IN ANATOMY—The Secretary, London Hospital Medical College, Turner Street, London, E.1 (January 31).

MINERALOGIST at the Tasmanian Museum, Hobart—The Agent-General for Tasmania, 457 Strand, London, W.C.2 (January 31).

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree in mathematics or physics, or evidence of exceptionally high professional attainment) in the Royal Naval Scientific Service at the Admiralty Research Laboratory, Teddington—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4115/52 (January 31).

RESEARCH ASSISTANT (with at least one year's industrial or academic research experience, and preferably an M.Sc. or Ph.D.) to carry out experimental work on cationic polymerization and related problems—Dr. P. H. Plesch, Chemistry Department, University College of North Staffordshire, Keele, North Staffs (January 31).

SENIOR LECTURER IN MATHEMATICS (with qualifications in applied mathematics)—The Registrars, The University, Manchester (January 31).

DEPARTMENTAL ASSISTANT (female honours graduate) TO THE PROFESSOR OF PSYCHOLOGICAL MEDICINE.—The Registrar, King's College, Newcastle-upon-Tyne (February 1).

RESEARCH FELLOWSHIP IN AERONAUTICS recently established by the English Electric Company—The Secretary of University Court, The University, Glasgow (February 8).

LECTURER IN APPLIED VETERINARY PATHOLOGY (Meat Inspection)—The Registrar, The University, Liverpool (February 9).

LECTURERS (with a degree in electrical engineering or an equivalent qualification; experience in light current, radio or radar engineering is essential) at the R.E.M.E. Training Centre, Arborfield, under the War Department—The Under-Secretary of State, War Office (M.E.1), London, S.W.1 (February 11).

LECTURER IN BOTANY at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (February 15).

LECTURER IN CIVIL ENGINEERING at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (February 15).

SENIOR LECTURER IN CIVIL ENGINEERING at the University of Queensland—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (February 23).

DIRECTOR of the Canterbury Agricultural College, University of New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (February 29).

FELLOWSHIPS IN CANCER RESEARCH offered by the National Cancer Institute of Canada and the American Cancer Society—The Secretary-General, British Empire Cancer Campaign, 11 Grosvenor Crescent, London, S.W.1 (February 29).

CHAIR OF CIVIL ENGINEERING at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (March 3).

SENIOR LECTURER IN APPLIED MATHEMATICS at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (March 3).

BROTHERTON CHAIR OF BACTERIOLOGY—The Registrar, The University, Leeds 2 (March 17).

BOSCH CHAIR OF BACTERIOLOGY at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (March 31).

SENIOR LECTURER IN COAL-MINING in the School of Mines, University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (March 31).

I.C.I. RESEARCH FELLOWSHIPS IN BIOCHEMISTRY, CHEMISTRY, ENGINEERING, PHARMACOLOGY, PHYSICS OR ALLIED SUBJECTS—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

FELLOWSHIPS IN CANCER RESEARCH—The Secretary-General, British Empire Cancer Campaign, 11 Grosvenor Crescent, London, S.W.1 (May 1).

AGRICULTURAL OFFICERS (with a degree in agriculture and not less than two years post-graduate training or experience in agriculture) in the Colonial Agricultural Service in East and West Africa—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

ASSISTANT (with degree, or equivalent, in metallurgy, chemistry, physics or engineering) IN THE INFORMATION DEPARTMENT—The Secretary, British Non-Ferrous Metals Research Association, Euston Street, London, N.W.1.

ASSISTANT (temporary) TO OFFICER-IN-CHARGE OF FALKLAND ISLANDS DEPENDENCIES SCIENTIFIC BUREAU (Westminster, London, S.W.1) to assist Head of Bureau generally, and in particular with extraction of material from reports received from Antarctic, etc.—The Under-Secretary of State, Research Department (S.610), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

ASSISTANT (Grade B) IN THE DEPARTMENT OF PHYSICS—The Principal, Technical College, Queen Street South, Huddersfield.

ASSISTANT LECTURER (Grade B) IN THE DEPARTMENT OF PHYSICS—The Principal, Sir John Cass College, Jewry Street, London, E.C.3.

CHAIR OF PHILOSOPHY—The Registrar, The University, Bristol 8.

CHEMISTS at a Ministry of Supply research and development establishment in Berkshire: EXPERIMENTAL OFFICER to supervise the work of an industrial chemistry laboratory engaged in a variety of chemical services to the establishment, including the testing of industrial and sewage effluents, control of chemical processes, boiler water treatment, etc., and an ASSISTANT EXPERIMENTAL OFFICER to assist in the work detailed above—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting F.935/51A.

CHEMISTS (Experimental Officer grade) in Ministry of Supply research and development establishments mainly in the vicinity of Waltham Abbey, Sevenoaks, South-East London and Staffordshire—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting F.607/51A.

CIVIL ENGINEERS (Main grade) (Ref. E.251/51A) and ASSISTANT CIVIL ENGINEERS (Recruitment grade) (Ref. E.252/51A) in the Air Ministry Directorate General of Works in London and the Provinces—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting the appropriate Ref. No.

ENGINEERS and PHYSICISTS for investigations on (*a*) novel sources of electrical energy (experience needed in instrumentation or automatic control), (*b*) principles of the solid state as applied to dielectrics, (*c*) gaseous ignition, (*d*) high-frequency communications, and (*e*) research on light-current and power components—The Director, Electrical Research Association Laboratory, Wadsworth Road, Perivale, Greenford, Middx.

EXPERIMENTAL OFFICERS at the Atomic Energy Research Establishment, Harwell, for work in physics, electronics and scientific computing (Ref. A. 309/51A), and chemistry (other than organic chemistry), chemical engineering and metallurgy (Ref. F.777/51A)—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting the appropriate Ref. No.

EXPERIMENTAL OFFICERS at the Royal Aircraft Establishment, South Farnborough: SENIOR EXPERIMENTAL OFFICER (Ref. D.585/51A), ELECTRONIC ENGINEER for (*a*) R.F. measurements in the V.H.F. and centimetric bands, (*b*) design of R.F. systems operating in these frequency bands, (*c*) design of electronic test equipment, (*d*) general circuit design; SENIOR EXPERIMENTAL OFFICER or EXPERIMENTAL OFFICER (Ref. D.586/51A), ELECTRONIC ENGINEER for radar applications work; EXPERIMENTAL OFFICER or ASSISTANT EXPERIMENTAL OFFICER (Ref. D.587/51A), ELECTRICAL or MECHANICAL ENGINEER for work on the development of aircraft equipment and associated installation in aircraft—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

LECTURER IN BACTERIOLOGY and HEAD OF THE SUB-DEPARTMENT OF DAIRYING in the School of Agriculture—The Registrar, The University, Nottingham.

PHYSICAL CHEMISTS (Scientific Officer grade) in Ministry of Supply experimental establishments mainly in the vicinity of Waltham Abbey, Sevenoaks, and South-East London—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting F.603/51A.

PHYSICISTS and ELECTRICAL ENGINEERS (Senior Principal Scientific Officer grade) (with a first- or second-class honours degree in the appropriate subject, or equivalent qualification) at the Royal Aircraft Establishment, South Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting D.571/51A.

PROFESSOR OF AGRICULTURE (to deal with agricultural methods, the management of tea and rubber estates, and fruit and vegetable cultivation), and a PROFESSOR OF ANIMAL HUSBANDRY (to deal with problems of animal breeding and the production of animal fodder) at the University of Ceylon, Peradeniya—The Ministry of Labour and National Service (A.S.12), Almack House, 26 King Street, London, S.W.1, quoting A.12/CE/122/123.

SCIENTIFIC ASSISTANT (with a degree in agriculture or natural science as well as a knowledge of foreign languages, preferably Spanish and Portuguese), mainly for examining and abstracting scientific literature on grassland and field crop research—The Director, Commonwealth Bureau of Pastures and Field Crops, Penglais, Aberystwyth.

SENIOR ENGINEER IN THE DEPARTMENT OF COMMERCE AND INDUSTRIES, Nigeria—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.28738.B.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Standard 1121, Part 22: 1951, Methods for the Analysis of Iron and Steel, Part 22, Tin in Ferro-Tungsten and Tungsten Metal. Pp. 8. (London: British Standards Institution, 1951). 1s. net. [2910

Agricultural Research Institute of Northern Ireland. Twenty-fourth Annual Report, 1950–1951. Pp. 34. (Hillsborough, Co. Down: Agricultural Research Institute of Northern Ireland, 1951.) [2910

N.B.L. Book List, Second Series: Psychology. (Published for the National Book League). Pp. 32. (London: Cambridge University Press, 1951.) 1s. [2910

General Register Office. Studies on Medical and Population Subjects, No. 5: Internal Migration; some Aspects of Population Movements within England and Wales. By Mary P. Newton and James R. Jeffery. Pp. 44. ((London: H.M. Stationery Office, 1951.) 1s. 6d. net. [2910

Scheme for a Part-Time Course in Chemical Engineering. Pp. 23. (London: Institution of Chemical Engineers, 1951). 2s. [2910

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences, No. 629, Vol. 235: Phyllotaxis, its Quantitative Expression and Relation to Growth in the Apex. By F. J. Richards. Pp. 509–564. (London: Cambridge University Press, 1951.) 13s. [2910

Other Countries

Bibliographie des Livres Français de Technologie et d'Industrie publiés de 1940 à 1950. Pp. viii+120. (Paris: Syndicat National des Éditeurs, 1950.) [2910

Unesco. Report on the Activities and the Meeting of the Co-ordinating Committee on Abstracting and Indexing in the Medical and Biological Sciences. Pp. 92. (Paris: Unesco; London: H.M. Stationery Office, 1951). 5s., 85 cents; 250 francs. [2910

Zoology Publications from Victoria University College. No. 11: Insects collected from Aircraft arriving in New Zealand from Abroad. By Marshall Laird. Pp. 30. (Wellington: Victoria University College, 1951.) [2910

Catalogues

Towers Streamline Hydrometers of Guaranteed Accuracy. (List No. 621.) Pp. 20. (Widnes: J. W. Towers and Co., Ltd., 1951.)

Old Medicine. (Catalogue 18.) Pp. 66. (London: E. Weil, c/o National Provincial Bank, 9 Market Place, N.W.11, 1951.)

Brüel and Kjaer Apparatus for Teletechnical, Acoustical and Medical Research. Pp. 38. (Hythe, Southampton: Thermionic Products, Ltd., 1951.)